THURSDAY, MARCH 7, 1895.

THE ANCESTRY OF THE VERTEBRATES.

Amphioxus and the Ancestry of the Vertebrates. By Arthur Willey, B.Sc., Tutor in Biology, Columbia College; Balfour Student of the University of Cambridge. With a preface by Henry Fairfield Osborn. (Columbia University Biological Series, II.) (New York and London: Macmillan and Co., 1894.)

THE observations on Amphioxus made before the second half of the present century, amongst which those of Johannes Müller take a foremost place, showed that this remarkable animal bears certain resemblances to Vertebrates; and since then its interest in this respect has gradually become more apparent. The extent to which our knowledge of its structure and development has recently increased, is indicated by the fact that about two-thirds of the papers dealing with Amphioxus quoted by Mr. Willey have appeared during the last ten years. With the exception of the admirable account given by the late Prof. Milnes Marshall, ast year, in his "Vertebrate Embryology," most of the works relating to this form are of a special nature, and to many not easily accessible. A consecutive history of the more recent observations was, therefore, greatly needed by those whose opportunities did not permit them to follow out the matter for themselves, and who will welcome a book written in an extremely lucid style by a naturalist who can speak with authority on the subject.

After giving an excellent description of the habits, anatomy, and development of Amphioxus, Mr. Willey devotes a special section to the Ascidians. Then follows a section on "the Protochordata in their relation to the problem of Vertebrate descent," which includes an account of the so-called "Hemichorda," together with a number of details relating to larval forms, Nemertines, and Vertebrates. On the basis of the facts stated, there is a considerable amount of theoretical matter dealing with the complex question included in the title of the book, in the discussion of which the author is not dogmatic, and makes the distinction between fact and theory clear to the reader. Of the very few inaccuracies we have noticed, mention need only be made of the statements with regard to the cilia on the ectoderm of craniate Vertebrates, on p. 176, and to the distribution of the ganglion-cells in the nerve-cord of Annulates, on p. 260, both of which require modification. The figures, which are 135 in number, are extremely good and clear, not a few of them being taken from the author's original papers; and a good bibliography is given at the end. Altogether we congratulate Prof. Osborn on the publication of the second of the series which is appearing under his editorship.

The problem of the ancestry of the Vertebrates has been approached from many different points of view, and some of the various theories advanced—such as the well-known "Annelid theory" of Semper and Dohrn—have been supported by so many facts and arguments as to gain for them many adherents. Others, again, were less fortunate, and cannot be said to have held the field at all. In all such phylogenetic speculations, as Mr. Willey points out, mere parallelisms are often difficult to distinguish from true affinities; and even with the increase in our knowledge during the past few years, we are stil so much in the dark that it is hardly possible to do more than accept provisionally any particular theory which appears to be supported by the greatest number of facts.

Although Amphioxus and the Ascidians have long been recognised as of extreme importance in helping to throw light on the question of Vertebrate ancestry, their many peculiarities are so difficult to explain that by many zoologists they have been attributed to degeneration—more especially in the case of the Ascidians—and on this supposition these animals can be of little use in helping us to any sound view as to the form and structure of the proximate ancestor of the Vertebrates.

The more recent researches on the structure and development of Amphioxus have, however, shown that, specialised as this animal undoubtedly is, it can no longer be so easily put on one side, and that it, at any rate, almost certainly represents an extremely archaic form. The general lines of its early development, for the knowledge of which we are mainly indebted to Kowalewsky and Hatschek, are now a matter of every-day knowledge, and are almost universally accepted as the best possible starting-point for the study of Embryology generally. In the present notice we can only refer to some of the more recent discoveries and theories as stated by Mr. Willey.

The curious tongue-bars in the gill-slits, which are only known to be represented elsewhere in Balanoglossus, are supposed by Mr Willey to be the "functionally active organs, of which the thymus of the higher forms is a metamorphosed derivative." This view is supported by reference to Dohrn's account of the development of the thymus in Selachisms. In a note on p. 42, the metapleural folds of Amphioxus and the evolution of the lateral fin-folds and lateral line of Vertebrates are made the subject of a hypothesis which cannot be done justice to in a few lines. The discovery of the excretory tubules by Boveri and Weiss, is one of the most interesting points which have recently come to light with regard to Amphioxus; and Mr. Willey supports Boveri's view that, in spite of their special peculiarities, they represent the pronephric system of Vertebrates, and that the pronephric ducts of the latter are partially homologous with the atrial chamber of Amphioxus. This conclusion is especially important as furnishing another argument against the Annelid theory, to which, moreover, the nervous system of Amphioxus lends no support, although its peripheral portion "can only be compared definitely, at present, in its broader features, with that of the higher Vertebrates."

The remarkable asymmetry of the larvæ of Amphioxus has probably no ancestral significance, and Mr. Willey concludes that it "is of no specific advantage whatever to the larvæ, but is merely a stage, which has been preserved in the ontogeny, of a topographical readjustment of parts necessitated by the removal of the mouth from its primitive mid-dorsal position in consequence of the secondary forward extension of the notochord, which has thus caused a virtual semi-rotation of the pharyngeal region of the body. On the other hand, the forward extension of the notochord is a distinct advantage in

later life, since by giving resistancy to the snout, it enables the animal to burrow its way into the sand with such astonishing facility, while the fact that it grows to the front end of the body at a very early stage in the embryonic development, long before it comes to be put to this definite use, must be regarded as an instance of *precocious* development, of which there are numerous and otherwise inexplicable examples in the field of comparative embryology." The author regards it as probable that the proximate common ancestor of Amphioxus and the higher Vertebrates was characterised by the possession of from nine to fourteen pairs of gill-slits, counting the "club-shaped gland" as representing the antimere of the first primary slit.

After an account of the structure of the Ascidians, these animals are compared with Amphioxus, and are defined as "more or less *Amphioxus-like* creatures which have become adapted to a sessile habit of existence." Their embryology is then described, and it is pointed out that development proceeds along parallel lines in them and Amphioxus "up to a certain point, and then at the time of the outgrowth of the tail in the embryo of the former, and the hatching of the embryo of the latter, divergences set in." The precocious formation of the larval tail in Ascidians is shown to be one of the chief evidences of the abbreviation which has occurred in the development of this group.

Metamerism—"that fetish of the morphologists," as Brooks calls it—may, as this author points out in his monograph on Salpa, "have been acquired by the ancestors of the Vertebrates after the divergence of the Tunicates"; and consequently, even if the supposed metamerism of the tail in Appendicularia had not now been definitely shown by Seeliger and Lefevre to be artificial, it could hardly have been considered of ancestral significance. Mr. Willey recognises the secondary nature of the "so-called metamerism" of the tail in this animal, and is inclined to conclude that "the Appendiculariæ represent Ascidian larvæ which have become secondarily adapted to a pelagic life, and have acquired the faculty of attaining sexual maturity." We feel, however, that the arguments brought forward are hardly sufficient to balance those in favour of the view held by Brooks and many others, that Appendicularia is the more primitive type, though until the development of this form is known we cannot, as Mr. Willey points out, decide definitely between these two views.

As already indicated, Bateson's grouping of Balanoglossus, Cephalodiscus, and Rhabdopleura into the division *Hemichorda* of the group *Protochordata*, is accepted by the author, and these forms are described and compared, and an account of the development of Tornaria and of Echinoderm larvæ given. Although we fully appreciate the general force of the quotation from Weismann, given at the head of Section V., the perusal of the following pages will not, we fear, be convincing to everyone that it applies in this particular instance. Such arguments as those brought forward by Spengel in his great monograph on the Enteropneusta cannot easily be put on one side, and we must make allowance for the principle of parallelism in evolution quite as much in this case as in that of the Annelid theory. Nevertheless, whether the Hemichorda hypothesis proves to be true or falls to the ground, it will have had its value in stimulating inquiry.

So many other points of theoretical interest naturally appear in considering the problem of Vertebrate ancestry, that one is tempted to discuss each as it arises. We must, however, content ourselves with a bare statement of certain only of these, and the conclusions at which Mr. Willey has arrived with regard to them.

It is concluded "that the ventral mouth of the craniate Vertebrates is the homologue of the dorsal mouth as we find it in the Protochordates, and that its direction of evolution has been, as was so ably maintained by Balfour, from the cyclostomatous to the gnathostomatous condition." The hypophysis is supposed to have arisen "in connection with a functional neuropore; when the neuropore ceased to be functional, there was no longer any bond of union between its inner portion, which opened into the cerebral cavity, and its outer portion, which opened into the buccal cavity; and these two portions became separated by differential growth of the cerebral and body-walls." Much stress—we are inclined to think too much—is laid on the pre-oral lobe, which is supposed to be "represented in the craniate Vertebrates by the *præmandibular head-cavities*."

In conclusion, we cannot do better than quote the last paragraph of Mr. Willey's useful and suggestive book, which is dedicated to Prof. Lankester:—

"For the present we may conclude that the proximate ancestor of the Vertebrates was a free-swimming animal intermediate in organisation between an Ascidian tadpole and Amphioxus, possessing the dorsal mouth, hypophysis, and restricted notochord of the former; and the myotomes, cœlomic epithelium, and straight alimentary canal of the latter. The ultimate or primordial ancestor of the Vertebrates would, on the contrary, be a worm-like animal whose organisation was approximately on a level with that of the bilateral ancestors of the Echinoderms." W. N. P.

A CYCLOPÆDIA OF NAMES.

The Cyclopædia of Names. Edited by Benjamin E. Smith, A.M. Pp. 1085. (London: Fisher Unwin, 1894.)

THE production of a pronouncing and etymological dictionary of proper names, encyclopædic in its scope and fulness, must have involved an immense amount of care and industry. The ponderous tome which represents the result of such labour comprises—to quote from the Editor's introductory remarks—"not only names in biography and geography, but also names of races and tribes, mythological and legendary persons and places, characters and objects in fiction, stars and constellations, notable buildings and archæological monuments, works of art, institutions (academies, universities, societies, legislative bodies, orders, clubs, &c.), historical events (wars, battles, treaties, conventions, &c.), sects, parties, noted streets and squares, books, plays, operas, celebrated gems, vessels (warships, yachts, &c.), and horses. Pseudonyms, also, which have literary importance, are included. The only condition of insertion has been that the name should be one about which information would be likely to be sought."

The condition expressed in the last sentence is one that may be regarded as essential, and only by adopting it as a guiding principle can any dictionary or cyclopædia worthy of the name be constructed. It follows from this that the various groups of subjects could not be presented with equal fulness; accordingly we find that persons and places are given a much greater amount of space than any other class. The personal names included in the volume embrace not only actual biography, but also mythology, legend, and fiction. We are chiefly concerned with the names of men of science, and, so far as can be judged from test references, few names of importance have been omitted. But even if a few omissions have been committed, it would be ungracious to condemn the work on that score; rather let us marvel at the number of names that have not been overlooked, and at the care which must have been expended in bringing so much accurate information together. Who but those that have had to investigate biographical details can understand the difficulties which crop up in the matter of dates, due to different styles of reckoning, and the differences between various authorities? It cannot be laid down that in every case the most trustworthy authority has been selected; nevertheless, there is ample evidence in the volume to show that judicious discrimination has been used.

The geographical names given include every town, place, or locality likely to be looked for by the average man; physical and political divisions of the earth; rivers, lakes, seas, &c.; and natural curiosities. In the spelling of place-names, the established usage in the language from which the name is taken has generally been accepted. In many cases, however, where the established English usage differs more or less from the native form, no general considerations can be applied. Instances of this are: Munich for the German München, Flushing for the Dutch Vlissingen, Hanover for the German Hannover. Having regard to the fact that there is a tendency to return to the native form of spelling place-names, where the difference between this form and the Anglicised orthography is slight (as in Hannover), the former has usually been taken. This seems to be a common-sense rule to follow, and it enforces the opinion of many geographers that the correct spelling of a place-name is the local one.

The general plan of the dictionary will be understood from the foregoing brief description. It only remains to be said that, as a collection of proper names, the work is the most complete one-volume cyclopædia that has ever come under our notice. No scientific society should be without the volume, and every reference library ought to have a copy on its shelves.

OUR BOOK SHELF.

Varied Occupations in Weaving. By Louisa Walker. Pp. 224. (London: Macmillan and Co., 1895.)

THERE is a scientific and an artistic side to the kindergarten system of education. Froebel's graduated sets of simple apparatus, known as "gifts," are most valuable in training a child to observe and think. The first of the gifts, consisting of six wool balls, coloured respectively violet, blue, green, yellow, orange, and red, serve to teach elementary colours; the second, consisting of a wooden cube, a sphere, and a cylinder, is used to familiarise children with geometrical forms, and with the figures presented when the objects are rotated around different axes. A number of other gifts follow these, each calculated to develop the minds of the infants for whom they are intended. So much cannot be said, however, for all the "varied occupations" which are carried on in many elementary schools. The educational value of an occupation such as that described in the book before us, lies not in the development of the mind, but in the training of the hand and eye. If the elements of kindergarten knowledge have been previously acquired by the young students, there is no harm in teaching how to weave paper mats, and to do macramé work, though our opinion is that the child might be better employed in object-lessons, which naturally follow a scientifically arranged kindergarten course. For this playing at making things is often carried too far, and leads to technical instruction being given before instruction in the broad principles inculcated by means of Froebel's early gifts. Possibly we do not fully appreciate the value of hand and eye training for children. The greatest benefit to be derived from such training seems to be the cultivation of the imitative and inventive faculties. Addition and multiplication can be taught by the weaving occupations described by Mrs. Walker, but they can be taught just as well by means of Froebel's gifts. However, the book is the outcome of twenty years' experience in kindergarten methods of teaching, and therefore should be of great service to teachers of children, even though its value, when viewed from a scientific point of view, is but little.

Horse Breeding for Farmers. By Alfred E. Pease. (London: Macmillan and Co., 1894.)

THE aim and object of this little work is to impress upon the impecunious present-day farmer the pecuniary profit which is to be derived from horse-breeding; and if the balance-sheets which Mr. Pease produces are to be relied upon, it undoubtedly constitutes a profitable pursuit. Unfortunately, however, so much depends upon the judgment, care, and skill bestowed by the individual in the purchase of suitable mares, the selection of proper sires, as well as upon the business capacity of the breeder, when the time arrives for placing the produce upon the market, that a profit on paper may readily be converted into a loss in practice. More particularly is this so in the case of the lighter breeds, such as the hunter and high-class carriage horse, whose value is largely dependent upon the thoroughness with which they have been trained and schooled. Mainly for these reasons we believe that the average farmer will be best advised to confine his horse-breeding operations to the heavier or agricultural breeds. They possess the additional advantage of being more docile, less trouble to break in, more useful to the farmer whilst young, and, finally, are more readily disposed of. The other breeds are best left to the landowners and so-called gentleman-farmer. Holding these views, we regret Mr. Pease should devote twenty pages to tracing the origin and history of the English thoroughbred, the Arab, the Barb, and other Oriental breeds.

For the rest, the book is replete with valuable information on the subject it professes to deal with, and may be cordially and unreservedly recommended to those who are inclined to try their luck in horse-breeding. To our minds, the final chapter, which treats of the ailments which horseflesh is heir to, is the least satisfactory. This is hardly to be wondered at, when we bear in mind how wide a subject is veterinary science, and how small a space Mr. Pease has devoted to its consideration. W. F. G.

Preparatory Physics. By William J. Hopkins. (London: Longmans, Green, and Co., 1894.)

THE course here presented is the outgrowth of needs of the classes beginning the study of physics in the Drexel Institute, Philadelphia. It is arranged strictly for laboratory work, and although the ground covered is not very extensive, yet sufficient has been selected for a first course, and that expounded to a very full extent. Mechanics has been chiefly taken in hand, and the numerous problems have been so arranged that the student is able to investigate them experimentally for himself. A glance at the instructions and explanations shows one that the author wishes at every step to instil into the beginner the idea that habits of accurate and thorough observation must be developed, and, further, that students must be careful, complete, and orderly in recording and arranging his results. With this intention most of the experiments are accompanied with printed forms illustrating concise methods of recording the observations. The apparatus alluded to in the text is of a simple nature, and quite sufficient for those beginning the subject. As an introduction, a few pages are devoted to such fundamental points as units, errors and sources of error, coordinates, plotting of curves, &c. Altogether, the book will be found a serviceable and able help to all wishing to take part in the more simple laboratory work.

The Story of the Stars. By George F. Chambers, F.R.A.S. Pp. 192. (London: George Newnes, Limited, 1895.)

ONE or both of two qualifications are essential in a book designed for general readers: the text must be attractively written, or the illustrations must please the eye. This book has neither of these claims to public favour: the text is stodgy and the illustrations are the very worst that we have seen disfiguring a volume on astronomy. The former defect is due to the author's attempt to say something about the whole of sidereal astronomy in less than two hundred small pages; the wretched illustrations cannot be due to his inability to find others, so this fault must lie at the publisher's door. And yet we cannot understand why the publisher of the *Strand Magazine* and other pictorial papers could not give the same care to the illustration of a book on astronomy as he does to the description of the home of some celebrity. Only in regard to quantity of information are we able to say a favourable word for this book. Mr. Chambers is thoroughly competent to collect the facts belonging to the old astronomy, and to condense them. He may be able to compress a mass of knowledge into a small compass, but his latest production shows that he has not the touch *simplex munditiis* of a writer for the popular mind.

Aërial Navigation: Proceedings of the International Conference held at Chicago, August 1893. Pp. 429. (New York: *American Engineer* Office. London: Sampson Low, Marston, & Co., 1894.)

AN International Conference on aërial navigation formed one of the series of Congresses which were held in Chicago during the summer of 1893. The meetings proved to be successful, and the volume in which the proceedings are recorded shows that facts and positive knowledge, rather than speculations or descriptions of things "in the air," were the order of the day. Some thirty-five papers were presented, each containing an account of observations and results of experiments carried out by scientific men or experienced engineers. These papers and the discussions upon them are now published in a volume uniform with Mr. Chanute's treatise on "Flying Machines," previously noticed in NATURE (vol. l. p. 569, 1894). Both show that many of the problems of aeronautics and aviation are being treated scientifically. The present volume is of special interest to meteorologists, for it contains several papers on the exploration of the upper atmosphere.

LETTERS TO THE EDITOR.

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The Liquefaction of Gases.

I DECLINE to follow Prof. Dewar into the fresh crop of irrelevant side issues raised by his letter in NATURE of February 28. The charge brought against Prof. Dewar, which I think I have amply substantiated, is that he has allowed the impression to go abroad that he has carried out much original research into the methods of liquefying the more permanent gases, and the properties of the liquids produced; whereas his experiments have been mainly repetitions of work done by others.

Prof. Dewar has not met this accusation. He has not proved that his methods for liquefying the more permanent gases are original methods, he has not even shown that for scientific purposes they are good methods; he has not proved that his experiments on the liquefied gases are either original or valuable; he has no attempted to rebut the actual facts, or to deal with the actual dates, brought forward by Prof. Olszewski and myself.

In his last letter Prof. Dewar gives a list of work "commenced and so far developed in the laboratory of the Royal Institution." The list might, however, have been made a little less grotesque by the omission of such things as "argon in liquid air," and the "liquefaction of hydrogen," and the substitution in place of these of a double &c.

When Prof. Dewar quits the region of romance, and tries to meet the definite statements I have made, and the evidence afforded by the dates I have quoted, I shall be ready to deal with his arguments to the best of my ability.

Cambridge, March 2. M. M. PATTISON MUIR.

Eleven-year Sun-spot Weather Period and its Multiples.

MANY years ago, investigations in regard to the existence of a period of about eleven years in the weather corresponding with the eleven-year sun-spot period were actively carried out in various parts of the world. Much data was accumulated in support of such a period, a large part of which was published in the earlier volumes of NATURE. But the investigations, as a whole, showed that the period was less marked or more complex than at first anticipated, so that recently less interest has been manifested in the subject, and indeed many express their doubts as to the existence of such a period.

One of the complexities which has helped to obscure the eleven-year period is the existence of what may perhaps be called weather harmonics, on account of the resemblance to harmonics in sound—that is, the existence of other periods related to the length of the first as 2, 3, 4, &c. Thus the existence of the eleven-year period is obscured by the existence of other periods of 22, 33, 44, &c., years.

If the reader will turn to the letter "On Some Temperature Variations in France and Greenland," in NATURE of October 11, 1894, he will find plotted the smoothed number of frost days and mean July temperatures at Paris for a large part of the present century. These curves show three marked waves in the temperature with the crests about 1825, 1848, and 1869, that is, almost exactly 22 years apart. If the dates of the chief maxima and minima of the individual curves are arranged under dates 22 years apart, as shown below, it will be seen that the dates closely approximate, thus:—

Mean dates of maxima	1825	... 1847	... 1869	... 1891
Frost days, Paris—minima	1824	... 1848	... 1868	... 1883
July temp. Paris—maxima	1826–34	... 1848	... 1870	... 1885
Mean dates of minima	1815	... 1837	... 1859	... 1881
Frost day, Paris—maxima	1814	... 1839	... 1856	... 1878–89
July temp. Paris—minima	1815	... 1842	... 1862	... 1881–90

If only the two highest maxima are considered, they occurred about 1826 and 1870, or 44 years apart; but if all the secondary

and chief maxima are considered, there are indications of an 11-year period, thus :—

Mean dates of minima—
1814 ... 1825 ... 1836 ... 1847 ... 1858 .. 1869 ... 1880 ... 1891
Frost days, Paris—maxima—
1814 ... 1830 ... 1839 ... — ... 1856 ... — ... 1878 ... 1889
July temp. Paris, minima—
1815 ... 1830 ... 1842 ... — ... 1862 ... — ... 1881 ... 1890

In the *Annals* of the Astronomical Observatory of Harvard College, vol. xxxi. part 1, p. 103, is given the average temperature for each five years, observed at a large number of stations in New England. The three stations having the longest records, namely, New Haven, Connecticut, Cambridge, Massachusetts, and New Bedford, Massachusetts, are given below :—

Year.	1781-85.	1786-90.	1791-95.	1796-00.	1801-05.	1806-10.	1811-15.	1816-20.	1821-25.	1826-30.	1831-35.
Cambridge			50·4	48·0	49 4	47·4					
New Bedford ...								48·1	49·5	49 6	48·2
New Haven	49·0	49·8	49·8	50·0	51 2	49·3	47·8	46·9	49·2	49 8	48·1

Year.	1836-40.	1841-45.	1846-50.	1851-55.	1856-60.	1861-65.	1866-70.	1871-75	1876-80.	1881-85.	1886-90.
Cambridge		46·6	47·7	47·4	47·1	48·1	47·1	46·4	48·5	48·5	49 0
New Bedford ...	47·0	47·8	48·8	48·6	47·9	49 9	48·3	47·1	49·1	48·1	47·9
New Haven	47·5	49 4	49·1	48·6	48·9	50 6			51·7	48·4	48·6

These records show that maxima occurred in New England about 1803, 1828, 1848, 1863, 1876, and 1889, and minima about 1818, 1838, 1858, and 1873. If these are arranged according to intervals of 22 years, as before, the following results are obtained :—

Mean dates of
maxima ... ... 1803 ... 1825 ... 1847 ... 1869 ... 1891
Observed max. temp.
New England ... 1803 .. 1828 ... 1848 ... 1863 ... 1889
Minima ... ... 1814 ... 1836 ... 1858 ... 1880
Observed ... ... 1818 ... 1838 ... 1858 ... 1873

It will be seen that the dates of maximum and minimum temperature correspond almost exactly with those observed in Paris, showing how general were the forces acting to produce them.

That there exists all over the world a tendency to a period of about 33 years, is so well worked out by Brückner, that it is only necessary to refer the reader to his treatise on "Klimaschwankungen seit 1700," to find exhaustive data on this subject.

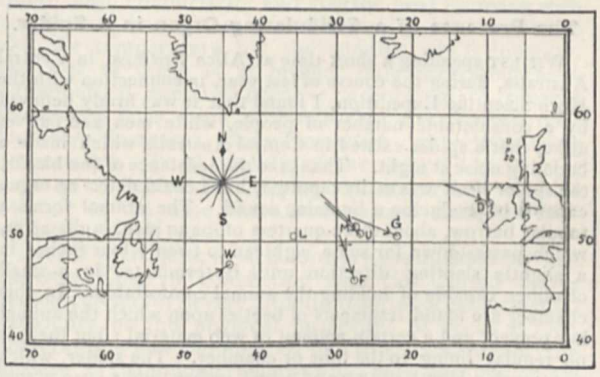
This harmonic tendency of multiplication in weather periods has been extensively worked out by the writer in shorter periods, and the evidence of its existence appears conclusive, based in that case on a very large mass of data. It is desired to call attention to it here, that those making future inquiries concerning sun-spot periodicity and the weather may bear the possibility of this phenomenon in mind. H. HELM CLAYTON.

Blue Hill Meteorological Observatory, Readville, Mass.

Abnormal Atlantic Waves.

In 1887 (NATURE, vol. xxxvii. p. 151) you kindly published a few remarks from me on the possible volcanic origin of the two waves which swept the decks of the steamers *Umbria* and *Faraday*, and which, from the data then available, seemed to have originated at a point in the Atlantic known as the "Faraday Reef," and marked with a cross (+) on the accompanying chart. I am now able to send you the details of a few similar cases which I have collected since then. The exact positions of the vessels, and the directions from which these solitary waves seemed to come, being also marked on the chart. In the case of H.M.S. *Orontes* the ship's course was not stated, and on account of darkness and other causes the directions from which some of the other waves came are not to be depended upon. None of these encounters would have been reported had they not caused much damage—masts and funnels going by the board, and bulwarks, deckhouses, and lifeboats being smashed; but many seafaring men can recall solitary and abnormally high waves having struck their vessels, although the sea was otherwise quiet. Amongst the strange results which these blows have produced, may be mentioned that the magnetism of the steamship *Energia* was thus suddenly altered sufficiently to introduce an error of 18° into the compass readings. The full details about this and a few other vessels have not been obtained.

North Atlantic.



Initial.	Ship's name.	Local time.	Date.	Latitude. North.	Longitude. West.	Speed.	Ship's course.	Wave's course.
				° ′	° ′	Knots.		
F	*Faraday*	6.45 a.m.	14/2/84	46 11	27 53	6	N. 72° E.	Port beam.
W	*Westernland* ...	2.45 a.m.	27/11/86	47 59	43 57	7	S. 60° W.	Bow.
G	*Germanic*	9.40 a.m.	5/5/87	50 36	22 8	4	N. 68° W.	Bow.
U	*Umbria*	4.40 a.m.	26/7/87	50 50	27 8	16	S. nearly W.	3 points on starboard bow.
	H.M.S. *Orontes*..	5 p.m.	18/2/91	36 12	32 50	9	?	Bow.
L	*Festina Lente* ...	noon.	16/11/94	50 12	35 23	?	S.E. by S.	?
M	*Manhattan*	2 a.m.	17/11/94	51 26	27 31	?	S. 86° W.	N.W.
D	*Diamond*	10 p.m.	21/11/94	53 9	9 52	Lying to	W.N.W.	W.N.W.

The following are short summaries of each case :

S.s. Faraday.—The wave was visible like a line of high land on the horizon about five minutes before it struck the vessel.

S.s. Westernland.—A huge wave rose to a great height just in advance of the ship. No other similar waves were met with. About noon the wind had changed from S.W. to W.N.W.

S.s. Germanic.—Wind W.N.W. with terrific squalls. Shipped a tremendous sea over bow.

S.s. Umbria.—The disturbance came from N.W. and consisted of two waves. The first one was broken, the second one green. The wind had previously changed from S.W. to N.W.

H.M.S. Orontes.—While steaming in smooth water a huge wave broke over the vessel forward.

S. Festina Lente.—A steep sea fell on board from both sides.

S.s. Manhattan. The sea was high, but fairly true until a mountainous wave broke on board from N.W.

S.s. Diamond.—Lying to, awaiting daylight to enter port. The wave was heard some time before it was seen, and then seemed to be about 40 feet high. The vessel never rose to it, but was literally submerged for a time.

An examination of the chart will show that with the exception of the *Westernland* each wave may have originated at a common centre, and might therefore be due to subaqueous volcanic activity. However, as the solitary waves which strike the west coast of South America and the so-called Death Waves on the west coast of Ireland are said to be regarded as precursors of storms, it is possible that these solitary Atlantic waves may be due to a similar cause ; but even then it is inexplicable how a number of comparatively small and regular waves can be converted into one abnormal one, or how the reported changes of wind and consequent confused sea could produce such a wave. It will be noticed that the dates for the *Festina Lente*, *Manhattan*, and *Diamond* are very close together, and therefore there is a possibility that they were struck by the same wave. C. E. STROMEYER.

Glasgow, February 18.

The Presence of a Stridulating Organ in a Spider.

WHILST spending a short time at Alice Springs, in Central Australia, during the course of last year, in connection with the Horn Scientific Expedition, I found that it was firmly believed by a considerable number of people, white men and natives alike, that a spider existed in Central Australia which made a booming noise at night. Thanks to the assistance of the blacks, the spider itself was easily captured, but I could detect no organ capable of producing a booming sound. The animal forms a tubular burrow, about three-quarters of, or an inch, in diameter, which passes down for some eighteen to twenty-four inches in a slightly slanting direction until it terminates in a small chamber capable of holding the animal comfortably. In this chamber are found fragments of beetles upon which the animal has preyed, and a certain amount of web material ; but there is no regular lining to the tube or chamber. The spider, which may reach a length of two and a half inches, and a span across the legs of five inches, proves to be *Phrictis crassipes*, belonging to the tribe *Territelariæ*, to which also belongs the well-known *Mygale*.

After listening carefully for the noise, and spending with a friend a night out in the open, in a spot where the booming could be heard, we came to the conclusion that the noise attributed to the spider was, in reality, made by a quail.

However, we kept some dozen specimens under observation in tin and wooden boxes, and after a few days in captivity, during which time they were very sluggish, one or two of them began to be more active, and on irritating one of the livelier ones (a large female) with a straw, I was pleased to see her rise on her hinder legs, and to hear her make a low whistling noise, moving alternately the palps up and down on the chelicerae as she did so. Whilst doing this she would make short angry darts at the straw.

On examination it was seen that the surface of the basal joint of the palp was provided with a somewhat oval-shaped comb-like structure composed of hard chitinous rods of various lengths, each ending in a club-shaped head. The comb is so placed that when the palp is moved up and down it rubs against a special part of the chelicera, which is provided with several rows of strong, sharply-tapering spines, and the sound produced can be heard, when the spider is in a box in a quiet room, at a distance of, at any rate, six or eight feet.

I was not at the time aware of the fact that, in the *Transactions* of the Entomological Society for 1877, Mr. Wood Mason had described a very similar stridulating organ in another ground-spider, *Mygale stridulans*, and it is interesting to note the close resemblance between, as well as the presence of, the organs in these two genera, both of which belong to the tribe *Territelariæ*. The figure given by Mr. Wood Mason admirably illustrates the position of the spider when it stridulates.

I hope to publish a full description of the organ in the volume dealing with the work of the Horn Expedition.

BALDWIN SPENCER.

Biological Laboratory, Melbourne University,
January 24.

The Spectrum Top.

PERHAPS some of your readers may be glad to learn that the curious phenomena of the spectrum top can be shown on a screen to a large audience. It is only necessary to paint the usual black lines and sector on a suitable disc of glass, and then to mount it in a revolving stage which can be rotated in a lantern by means of a multiplying wheel. The projected disc of light must not be too large ; if the lime-light be used the disc may be about 2 feet in diameter, and about double that size with the electric arc. A great variety of effects can be obtained by interposing coloured glasses in the path of the beam ; *e.g.* with a green glass, and in diffused gas-light, the dark sector and lines appear to be mauve-coloured when suddenly stopped after rapid rotation, or when very slowly rotated, but become of a dark blue when the gas is turned off. On rotating the disc in the usual way the lines appear to be blue, green, and violet.

With a blue glass in gas-light the dark sector and lines appear to be yellow when suddenly stopped, but a fine purple without diffused light. The colours given by the lines at a moderate rate of rotation are red, grey, green, and blue. With a monochromatic red glass, the lines appear to be blue, grey, red, and dark red.

Is it not somewhat extraordinary that a rich blue colour can be obtained when dealing only with monochromatic red light ? With whatever coloured light the disc is fed, the characteristic red lines at the centre, and blue at the periphery, or *vice versa*, seem almost invariably to appear. Altogether the phenomenon is worthy of further study by physiologists and physicists ; the lantern appears to throw, in a double sense, new light upon this interesting problem. The idea of employing transmitted instead of reflected light for producing the phenomena of the spectrum top is partly the suggestion of Mr. T. J. Walls, instrument maker, Edinburgh, who constructed the disc for me. DAWSON TURNER.

Edinburgh, March 4.

THE AGE OF THE EARTH.

PROF. PERRY and I had not to wait long after the publication of his article "On the Age of the Earth" (NATURE, January 3, 1895, pp. 224–227) to learn that there was no ground for the assumption of greater conductivity of rock at higher temperatures, on which his effort to find that the consolidation of the earth took place far earlier than 400 million years ago, is chiefly founded. In a letter of date January 13, most courteously written to me by Dr. Robert Weber in consequence of his having seen by my letter to Prof. Perry of December 13, that we were anxious to find how far his experimental results regarding differences of thermal conductivity and specific heat at different temperatures could be accepted as trustworthy, he tells me that he had made farther experiments on an improved plan, and that on the whole his investigations do not seem to prove augmentation of conductivity with temperature ; and he kindly gives me, with permission to communicate to NATURE, the following results, hitherto unpublished, of experiments which he made in the years 1885 and 1886,

on the thermal conductivities (k) and specific heats (c) of five rocks.

	Density	
Basalt	3·0144 ...	$c = 0·1763 + 0·000296t$ [between 0° and 60°]
		$c = 0·1946 + 0·000575(t - 60)$ [between 60° and 110°]
		$k = 0·00317\{1 + 0·00001t\}$
Marble ...	2·7036 ...	$c = 0·20279 + 0·000466.t$
		$k = 0·00540\{1 - 0·000005.t\}$
Rock salt ...	2·161 ...	$c = 0·2146 + 0·00017t$
		$k = 0·0137\{1 - ·0044t\}$
Anhydrite of Jura ...	2·892 ...	$c = 0·1802 + 0·0003.t$
		$k = 0·0123\{1 - 0·0024.t\}$
Quartz ...	2·638 ...	$c = 0·1754 + 0·0004.t$
		$k = 0·01576\{1 - 0·0019.t\}$

These results show practically no change of thermal conductivity with temperature for Basalt and Marble. For Rock Salt, Anhydrite of Jura, and Quartz, they show diminutions of thermal conductivity amounting per 100° C. to 44 per cent., 24 per cent., and 19 per cent. respectively. They contrast curiously with the 75 per cent. *augmentation* of thermal conductivity per 100° C. (NATURE, January 3, p. 226), used by Prof. Perry in his estimate of the age of the earth, and they form a practical comment on his statement (NATURE, January 3, p. 226) :—"From the analogies with electric conduc-"tion, one would say, without any experimenting, that as "a metal diminishes in conductivity with increase of "temperature, so a salt, a mixture of salts, a rock, may "be expected to increase in conductivity with increase of "temperature."

Since the beginning of January I have myself been endeavouring to find by experiment the proportionate differences of thermal conductivity of rocks at different temperatures; and before the end of January I had made some preliminary experiments on slate and sandstone, from which I was able to tell Prof. Perry that the thermal conductivity of each of these two rocks is probably less at higher temperatures than at lower. Since that time I have been arranging for experiments on granite, in which as rapid progress as I would have liked has been impossible for many reasons, including the necessity of standardising a Kew certificated thermometer of 1886, now for the first time being compared with an air thermometer in my laboratory. Unless its differences from the air thermometer are much larger than can be expected from what we know of the behaviour of mercury-in-glass thermometers generally, it is already almost proved that the thermal conductivity of granite is *less* between 150° C. and 250° than between 50° and 150°.

As to specific heats there can be little doubt but that *they* increase with temperature up to the melting point of rock, but the rate of augmentation assumed by Prof. Perry is about five times as much as that determined up to 1200° by the experiments of Rücker and Roberts-Austen (*Phil. Mag.*, 1891, second half-year, p. 353) for Basalt, and of Carl Barus (*Phil. Mag.*, 1893, first half-year, pp. 301–303) for Diabase; these being apparently the only experiments hitherto made on specific heats of rock at temperatures beyond the range of the mercury-in-glass thermometer.

Taking the primitive temperature as 4000° C. and the thermal conductivity and the specific heat at this temperature respectively 30 times and 14½ times their values at the surface, and throwing in a factor 3 for three-fold density at the greater depths (though the average density of the *whole* earth is scarcely double that of the upper crust) Perry takes the product of three factors $30 \times 14\frac{1}{2} \times 3$ and so finds in round numbers 1300 times my estimate as his corrected estimate of the age of the earth!! (NATURE, January 3, p. 227.)

But even if the ratios of thermal conductivities and of specific heats at the higher and lower temperatures were as assumed, Prof. Perry's product of the two corresponding factors vastly over-estimates the age. Of this I thought I had given a sufficient warning when I wrote to him (December 13), "But your solution on the supposition of an upper stratum of *constant* thickness, having smaller conductivity and smaller thermal capacity than the strata below it, is very far from being applicable to the true case in which the qualities depend on the temperature." (NATURE, January 3, p. 227.) It is obvious that the supposed higher thermal conductivity and the higher specific heat, if beginning suddenly at a short distance below the surface, and continuing constant to the great depth, would greatly prolong the time of cooling to the same surface-gradient, beyond what it would be with these qualities increasing continuously with temperature. For the simple case of conductivity assumed to increase in the same proportion as specific heat, Prof. Perry has himself since given in a later communication (NATURE, February 7, pp. 341–342) the necessary correction of his previous mathematics: and in an example of his own choosing (50 per cent. augmentation of each quality per 100° elevation of temperature), he now finds 121 times my estimate for the age of the earth, instead of 441 times as by the formula which he used in his first article.

When the ratio of thermal conductivity to specific heat per unit bulk varies with the temperature, the problem of secular cooling presents mathematical difficulties which, so far as I know, have not been hitherto attacked; but I find it quite amenable to analytical treatment, and I hope before long to be able to offer a paper to the Royal Society of Edinburgh on the subject, as an appendix to my original paper "On the Secular Cooling of the Earth," published in its *Transactions* (1862). I have already worked out numerically two cases, in one of which both conductivity and specific heat increase with temperature, and in the other the specific heat increases with the temperature but the conductivity is constant. The first of these is at present only interesting as a mathematical exercise because, according to present knowledge, it is more probable that the thermal conductivity decreases than increases with increasing temperature. To the results of the second I shall refer later as substantially helping us towards a revised estimate of the time which has elapsed since the consolidation of the earth.

Twelve years ago, in a laboratory established by Mr. Clarence King in connection with the United States Geological Survey, a very important series of experimental researches on the physical properties of rocks at high temperatures was commenced by Dr. Carl Barus for the purpose of supplying trustworthy data for geological theory. Mr. Clarence King, in an article "On the Age of the Earth" published in the *American Journal of Science* (vol. xlv., Jan. 1893), used data thus supplied, to estimate the age of the earth more definitely than was possible for me in 1862 with the very meagre information then available as to specific heats, thermal conductivities, and temperatures of fusion. I had taken 7000° F. (3871° C.) as a high estimate of the temperature of melting rock. Even then I might have taken something between 1000° C. and 2000° C. as more probable, but I was most anxious not to *under*-estimate the age of the earth, and so I founded my primary calculation on the 7000° F. for the temperature of melting rock. Now we know from the work of Carl Barus (*Phil. Mag.* 1893, first half-year, pp. 186, 187, 301–305) that Diabase, a typical Basalt of very primitive character, melts between 1100° C. and 1170° and is thoroughly liquid at 1200°. The correction from 3871° C. to 1200° or 1/3·22 of that value, for the temperature of solidification, would, with no other change of assumptions, reduce my estimate of 100 million to $1/(3·22)^2$ of its amount or a little less than ten million

years; but the effect of pressure on the temperature of solidification must also be taken into account, and Mr. Clarence King, after a careful scrutiny of all the data given to him for this purpose by Dr. Barus, concludes that without farther experimental data "we have no "warrant for extending the earth's age beyond 24 millions "of years."

By the solution of the conductivity problem to which I have referred above, with specific heat increasing up to the melting point, as found by Rücker and Roberts-Austen and by Barus, but with the conductivity assumed constant, and by taking into account the augmentation of melting temperature with pressure in a somewhat more complete manner than that adopted by Mr. Clarence King, I am not led to differ much from his estimate of 24 million years. But, until we know something more than we know at present as to the probable diminution, or still conceivably possible augmentation, of thermal conductivity with increasing temperature, it would be quite uninteresting to publish any closer estimate.

In the latter part of Mr. Clarence King's paper on the "Age of the Earth" the estimates of the age of the sun's heat by Helmholtz, Newcomb, and myself, are carefully considered, and the following sentences with which the paper is brought to a conclusion will, I am sure, be interesting to readers of NATURE:—"From this point of "view the conclusions of the earlier part of this paper "become of interest. The earth's age, about twenty-four "millions of years, accords with the fifteen or twenty "millions found for the sun.

"In so far as future investigation shall prove a secular "augmentation of the sun's emission from early to pre-"sent time in conformity with Lane's law, his age may "be lengthened, and further study of terrestrial conduc-"tivity will probably extend that of the earth.

"Yet the concordance of results between the ages of "sun and earth, certainly strengthens the physical case "and throws the burden of proof upon those who hold "to the vaguely vast age, derived from sedimentary "geology." KELVIN.

NOTES.

IN addition to Lord Aberdare, the Royal Society has to mourn the loss of two more of its Fellows. Sir Henry Rawlinson, the distinguished Orientalist, died on Tuesday, in his eighty-fifth year. He was elected into the Society so long ago as 1850. Sir William Savory, who died on Monday, at the age of sixty-nine, was admitted eight years later.

WE have also to announce the death of Dr. D. H. Tuke, well known for his works on psychological medicine.

IT is announced in the *British Medical Journal* that Dr. Armand Ruffer has tendered his resignation of the post of Director of the British Institution of Preventive Medicine.

WHEN the news of Prof. Cayley's death reached America, American mathematicians were not slow in expressing sympathy with their English brethren. We are informed that—"In that great American University, the Johns Hopkins, in which, not many years ago, Prof. Sylvester and Prof. Cayley, at the same time, gave instruction in advanced mathematics, the death of Prof. Cayley was the occasion of universal mourning, and all was appropriately draped with black."

IT appears from a correspondence between the Board of Trade and the Electric Lighting Committee of the St. Pancras Vestry, that Major Cardew, the electrical adviser of this department, has discovered, during his investigations into the recent explosions in the street boxes used for electrical supply in St. Pancras, that a remarkable deposit on some of the insulators contained a considerable quantity of the metal sodium. The presence of this metal appears to be so grave a source of danger, and to afford so reasonable an explanation, in connection with the accumulation of escaped coal-gas, of the several explosions which have recently occurred, that the Board of Trade intends to investigate the causes of the deposit of this substance with a view to its prevention, and in this investigation they have asked for the assistance of the Royal Society and of the Institution of Electrical Engineers.

PROF. CHARLES STEWART will deliver a course of six lectures on "The Internal Framework of Plants and Animals," at the Royal College of Surgeons, Lincoln's Inn Fields, on March 11, 13, 15, 18, 20, and 22, at five o'clock. Admission to the lectures can be obtained on presentation of visiting card.

A CORRESPONDENT, writing from Brooklyn on February 16, says:—The severity of the weather and depth of snowfall throughout the southern United States for the past few days are unparalleled. On the 14th inst. the temperature at Abilene, Texas, was 15°, and in the State of Georgia it ranged about 9° lower than in New York city. Yesterday there was snow five inches deep in Atlanta, four inches at Darien, three inches at Thomasville, and two inches at Savannah, all in Georgia; two feet at Birmingham, Alabama; eight inches at New Orleans, Louisiana; six inches at Galveston, Texas, with snow falling as far south as Corpus Christi. In many places there had never before been snow enough to cover the ground to any measurable depth.

FROST prevailed during the greater part of the past week in nearly all parts of the United Kingdom, and in the northern and midland districts the thermometer in the screen has on several nights fallen as much as 10° below the freezing point. Snow has fallen over the greater part of the country, and in Scotland the amount has been heavy. The type of weather has been chiefly anti-cyclonic, and an area of low barometer readings was for several days situated to the eastward of our islands, so that strong and cold northerly winds were experienced over the entire country. A correspondent at Dundee states that the temperature in that district during the last two months was unusually low. The average maximum temperature of January and February was 36°·6, and the average minimum, 24°·9, so that the average mean temperature for that vicinity was about 30°·7. The normal values published by the Meteorological Council for Leith, a little more to the south, give 39°·5 as the average mean temperature for the two months.

PROF. M. MÜLLER contributed an article to the January number of *Globus* (Brunswick) on meteorology and the figure of the earth, which contains much useful information upon the subject of atmospheric circulation, and the results of the author's own investigations. He points out very clearly the effects of the earth's rotation and of the polar compression on the motion of the air, and strongly opposes the theory of equatorial and polar currents as propounded by Dove and his adherents. He explains the enormous forces that would be required to transpose a kilogram of air from the pole to the equator, and shows that the motion of a particle closely resembles that of a ball which is kept in circular motion on a revolving plate by a juggler, the rapid rotation of the plate, and of the earth, acting similarly on both ball and air, and keeping both moving in comparatively small and nearly closed curves.

DR. A. CANCANI notes the existence of two systems of undulations in the Constantinople earthquake of July 10, 1894, one propagated with a velocity of 4·9 km. per second, the other with a velocity of 2·3 km. per second (*Rend. dell' Acc. dei*

Lincei, December 16, 1894). The latter estimate is obtained from the times furnished by magnetic or astronomical observatories, possessing instruments capable of recording long-period oscillations only. The instruments of the Italian seismic observatories, on the other hand, registered the rapid movements travelling with the greater velocity, as well as the longer oscillations, whose velocity is again found to be 2·3 km. per second. Dr. Cancani remarks that these results agree with the theory explained by him in a former paper (*Ann. dell' Uff. Centr. di Met. e Geod.* vol. xv. 1893).

NEWS has recently been received regarding the three attempts made last year to extend our knowledge of the higher mountains of Africa. The most important of these was Mr. Scott Elliot's expedition to Ruwenzori, some of the preliminary results of which he announced in a recent letter to NATURE. Mr. Scott Elliot seems to have found the higher slopes of the mountain extremely trying to the native porters. Botanical results of the highest interest may be expected from the work of such an experienced African botanist. As Mr. Scott Elliot did not succeed in reaching the highest zone in the mountain, his description of its geology may be incomplete. He has, however, announced one conclusion of the highest importance, viz. the discovery of traces of the existence of glaciers, seven miles below the existing snow-line. It will be remembered that in a recent paper published by the Geological Society, Dr. J. W. Gregory fully described similar glacial extension on Mount Kenya. The difficulty, however, has been felt that the same fact has not been recorded from Kilima Njaro, in spite of the numerous visits to that mountain. The glaciers there now seem to be at their greatest extension. It is probable that this is due to the fact that the peak with the existing glaciers is of very recent date. The absence of moraines from the older peak appeared perplexing. Mr. Scott Elliot's discovery, however, shows that the greater glaciation of Kenya was not due to a purely local cause, but to some change that affected the whole region.

WE have received a copy of the *British Central Africa Gazette* (vol. i. No. 15), describing Capt. Manning's recen ascent of Mount Mlanje, on October 22–25. The mountain ist now well known from the botanical collections made there by Mr. Whyte, under the direction of Mr. H. H. Johnston. Previous attempts to ascend it had, however, failed through lack of time. Capt. Manning's party do not appear to have found the climbing very difficult. The summit is estimated at 9680 feet; but we are not told by what method this was determined. Apparently it was only by aneroid. The party were helped up by a new method of roping, which ought to recommend itself to the Chamounix and Zermatt guides. They used a long loop of calico, which they called a "machila": the climber leant back at one end of it, six or eight strong men pulled at the other. Probably in time, to "machila the Matterhorn" will be the regular thing in a Swiss trip.

THE third expedition to which we have to refer, has unfortunately not been successful in its attempt to solve the mystery of the reported snow-clad mountain which occurs between Kenya and Abyssinia. The existence of this has been frequently reported since it was first recorded by Abbadie as Mount Wosho. It was hoped that Dr. Donaldson Smith's expedition would have finally settled this question of the height and position of this mountain. The expedition has, however, been stopped by the Abyssinians, and sent back to the Somali frontier at Barri. His companion, Mr. Gillatt, has been compelled to return home, but Dr. Smith has determined to continue the expedition. As the rainy season and unhealthy country are before him, and as such people as the Somali are easily dispirited by a first failure, it is hardly likely that Dr. Smith will reach Mount Wosho. He proposes to strike south for the Juba, and then westward across the Borana country to Basso Narok (Lake Rudolph). The expedition has already achieved some very interesting results, and if it succeed in its traverse of the Borana country, it will have amply atoned for its failure to reach its original goal of the Omo valley.

IN an address to the United States National Geographic Society, recently published in the *National Geographic Magazine*, Dr. C. Hart Merriam discusses the influence of temperature upon the geographical distribution of terrestrial animals and plants. It is well known that in the northern hemisphere animals and plants are distributed in circumpolar belts or zones, the boundaries of which follow lines of equal temperature; but difference of opinion prevails as to the period during which temperature exerts its restraining influence. Dr. Merriam opens new ground in the address to which we refer. Physiological botanists have long maintained that the various events in the life of plants, such as leafing, flowering, &c., take place when the plants have been exposed to definite quantities of heat, which are the sums total of the daily temperatures above a minimum (6° C.) assumed to be necessary for functional activity, and are termed the *physiological constants* of the particular stages. Dr. Merriam infers from this that there must also be a physiological constant for the species itself; and this *species constant* must be the total quantity of heat required by a given species to complete its cycle of development and reproduction. It follows that not only the mean temperature, but also the total quantity of heat in particular zones must be considered in estimating the influence of temperature upon the distribution of plants and animals. Dr. Merriam has constructed a pair of isothermal charts of the United States, of which one shows the distribution of the total quantity of heat during the season of growth and reproduction (*i.e.* the sum of daily mean temperatures above 6° C.), and the other the mean temperatures during the six hottest weeks of the year. By comparing these with a biogeographical chart of the same region, Dr. Merriman concludes, from the striking coincidences which occur, that animals and plants are restricted in northward distribution by the total quantity of heat during the season of growth and reproduction, and in southward distribution by the mean temperature of a brief period during the hottest part of the year. The anomalous intermingling of boreal and austral types which occurs over an extensive area of the Pacific coast of the United States becomes explicable by the establishment of these principles, for here alone is a low summer temperature combined with a high sum-total of heat—the two conditions which permit extensive mixture in the same region of northern and southern types.

A CASE of dual brain action, presenting points of special interest, both in physiology and psychology, is described in *Brain* (Part lxix.) by Mr. L. C. Bruce. The patient who formed the subject of observation varied considerably in his mental condition, and the most obvious phenomena observed during these changes were that in one condition he spoke the English language, and in the other the Welsh language. When in the former state, he was the subject of chronic mania. He was right-handed, and exhibited a fair amount of intelligence. He remembered clearly things he had noticed in previous English periods, but his memory was a blank to any that occurred during the Welsh stages. He wrote by preference with his right hand, his letters were fairly legible, and he wrote from left to right. If asked to do so, he would write with the left hand, but then produced mirror writing, traversing the paper from right to left. When in the Welsh stage, however, he was left-handed and the subject of dementia. His speech was almost unintelligible, but what could be understood was in the Welsh language. In this stage he had no idea of English,

and his mental and physical conditions altogether were the reverse of what they were in the English stage. From these observations, Mr. Bruce is led to believe that "the cerebral hemispheres are capable of individual mental action, and that the mentally active cerebrum has a preponderating influence over the control of the motor functions, the patient living two separate existences during the two stages through which he passes; the mental impressions received during each of these separate existences being recorded in one cerebral hemisphere only." If the cerebral hemispheres did not act independently, it is difficult to account for the patient's ignorance of events which happened to him in the Welsh stage when he passed into the English condition.

A NOTE on the electrostatic capacity of resistance coils wound in the ordinary way to avoid self-induction, is published in the *Comptes rendus* (February 11). The author (M. J. Cauro) has experimentally determined the electrostatic capacity of coils wound in several different ways, using for this purpose a Wheatstone's bridge arrangement with a commutator similar to that used by Ayrton and Perry in their secohmmeter. By comparing coils of practically the same shape and resistance the author finds that the errors due to capacity may, in the case of coils containing a large number of turns, be considerable when the ordinary double method of winding is adopted, but these errors are considerably reduced if the method of winding proposed by M. Chaperon is employed. The best results of all are obtained by winding the two wires in alternate layers, always starting from the same end of the bobbin, the wire being brought back parallel to the axis of the coil. For instance, with coils having a resistance of about 14,000 ohms and about 9500 turns, the three methods of winding give apparent self-induction (due to capacity) of $-1\cdot79$, $-0\cdot27$ and $-0\cdot16$ respectively. In order to make sure that the values obtained were really due to capacity, the author placed bundles of fine iron wire inside the different coils. The results obtained in this case were the same as those obtained without any iron core. By altering the connection of the two wires in the coil wound in the ordinary manner, so that the current traversed the two circuits in the same direction, the self-induction was found to be $0\cdot13$. Thus by winding the wire double, the error due to electrostatic capacity was about twelve times as great as the error to eliminate which this method of winding was adopted.

TWO volumes recently added to the comprehensive Aide Mémoire series, published jointly by Gauthier-Villars and Masson, Paris, are:—"Appareils Accessoires des Chaudières a Vapeur," by MM. Dudebout and Croneau, and "Traité des Bicycles et Bicyclettes" by Dr. C. Bourlet.

THE names of the members of the electrical and kindred industries throughout the world are contained in "The Universal Electrical Directory," published by Messrs. H. Alabaster, Gatehouse, and Co. For simplicity and facility of reference the names are divided into four groups—namely, British, Continental, American, and Colonial, which are again subdivided into alphabetical and classified sections. There are nearly twenty-one thousand names in all, or two thousand five hundred more names than were given in the Directory for 1894.

AMONG the forthcoming books to be published by Messrs. J. and A. Churchill, the following are announced to appear at an early date:—"A Manual of Botany" based on that of the late Prof. Bentley, vol. i., "Morphology and Anatomy," enriched with a large number of new illustrations, by Prof. J. Reynolds Green; "Elements of Health, an Introduction to the Study of Hygiene," by Dr. Louis C. Parkes; and "Mental Physiology, especially in its relation to Mental Disorders," with illustrations, by Dr. T. B. Hyslop.

A VALUABLE work on the climatology of Africa, and on the distribution of disease in that continent, has just appeared. It is entitled "Tropical Diseases in Africa," by Dr. R. W. Felkin, and is published by Mr. W. F. Clay, Edinburgh. The volume is based upon a lecture delivered at the African Ethnological Congress held at Chicago in 1893, and contains, as an appendix, a paper, read before the Budapest Congress last September, on a new method for graphically illustrating the geographical distribution of disease. The book forms an important addition to the literature upon tropical disease in Africa.

MEN of science are indebted to the beneficent provisions of the Smithsonian Institution for the generous distribution of scientific literature. A publication of special value to chemists is the "Bibliography of Aceto Acetic Ester and its Derivatives," by Mr. Paul H. Seymour, which, acting upon the recommendation of the American Association's Committee on Indexing Chemical Literature, the Institution has lately issued. The bibliography is arranged in chronological order from 1840, with author and subject indices appended. The outlines of memoirs are given, in order to show the scope of the originals. Mr. Seymour deserves the gratitude of chemists for this time-saving bibliography, upon which he has evidently bestowed much care.

ANOTHER paper prepared for the Committee on Indexing Chemical Literature, is "An Index to the Literature of Didymium," by Dr. A. C. Langmuir, just distributed as No. 972 of the Smithsonian Miscellaneous Collections. The index contains references to all the papers published on didymium, from the discovery of the element in 1842 to the year 1893. It furnishes a striking illustration of the wonderful results accomplished by the use of the spectroscope in modern chemistry. In addition to didymium, the following elements have now been indexed: Columbium, iridium, manganese, titanium, uranium, vanadium.

WE note the publication of the *Bulletin Météorologique* of the Imperial Observatory of Constantinople, for the year 1894. Although telegraphic observations have been published in the Paris weather report, we believe that very few regular observations from Constantinople have been received in this country for some twenty years. The bulletin contains some means derived from twenty-seven years' observations, which show that the maximum shade temperature was $99^{\circ}\cdot5$, in 1888, and the minimum, $17^{\circ}\cdot2$, in 1869. The average yearly rainfall is 23·3 inches, and the average frequency, eighty-six days. Snow falls on about fifteen days, and fog occurs, on an average, on fifty-nine days. An appendix contains a list of the earthquakes in the Ottoman empire during the year 1894.

A SKETCH of the attainments and life-work of Dr. T. B. Rake, who died at Trinidad last August, is given in the *Journal* of the Trinidad Field-Naturalists Club for December 1894. Dr. Rake was the superintendent of the Leper Asylum at Trinidad, and presided over the Leprosy Commission. The reports issued during his eight years' administration of the Asylum are of the highest value, for he was well acquainted with bacteriological methods of research, and he put on record numerous observations referring to the leprosy bacillus. He was not, however, only a high authority on leprosy, but an enthusiastic and keen observer of nature. At the time of his death he was the President of the Trinidad Field-Naturalists Club, the members of which will remember him for many years to come. An excellently reproduced portrait of Dr. Rake forms the frontispiece of the *Journal* containing the very appreciative obituary notice.

A MONUMENT to the humanitarian spirit of the members of the Mulhouse Association pour prevenir les Accidents des

Fabriques is afforded by a ponderous volume, the second edition of which has been received from the Association. The volume is entitled "Collection of Appliances and Apparatus for the Prevention of Accidents in Factories." It is illustrated by thirty-seven finely-drawn plates, and the text is printed in French, German, and English. The London agents are Messrs. Dulau and Co. What strikingly indicates the high motives which actuate the Association is that the volume is published at the price it cost to reproduce. The one object of publication is to spread the knowledge, and encourage the adoption, of the numerous appliances devised for the prevention of accidents from machinery. The factory inspector and manager, the mechanical engineer, and all others who are concerned in the construction and use of machinery, should see this very useful volume.

WE have received the first two numbers (1892–1893) of the yearly *Bulletin of the Geological Institution of the University of Upsala*. This is a publication that should be of great interest to all British geologists whose work lies among the Lower Palæozoic rocks, since on those strata Swedish researches have thrown so much light. Among the contents are two papers by C. Wiman, on the structure of Graptolites; stratigraphical papers, by the same author, and J. G. Andersson; petrographical and mineralogical papers, by Prof. Nordenskiold and H. Sjögren; and others. Nine plates in all, illustrate the numbers. The papers are all in either English or German (French is the only other language permitted); this will be satisfactory to those British geologists who have found the Swedish language a serious barrier to the study of important geological papers in the past. We may add that the *Bulletin* will be sent, not only to all geological institutions, but also to all private workers who send their publications regularly in exchange.

AMONG the new editions received during the past week, is the second edition of the "Introduction to Physiological Psychology" (Swan Sonnenschein and Co.), translated from the revised and enlarged second German edition of Dr. Trichen's work, reviewed in these columns four years ago (vol. xliv. p. 145). The chief addition is a chapter upon the emotional tone of the ideas. Another new edition (the fourth), just received, is "A Treatise on Elementary Trigonometry" (Longmans, Green, and Co.), by Dr. John Casey, F.R.S., edited by Prof. P. A. E. Dowling. This little work has found favour among many teachers and students, and the new issue should be even more popular. Dr. W. H. Besant's "Conic Sections" (George Bell and Sons) has reached a ninth edition. The articles on reciprocal polars have been expanded into a separate chapter, and a chapter on conical projections has been inserted. Two other books, which may be included among new issues, belong to the handy series of Economic Classics published by Messrs. Macmillan and Co. One consists of select chapters and passages from Adam Smith's "Wealth of Nations"; the other contains the first six chapters of Ricardo's "Principles of Political Economy and Taxation."

MESSRS. SWAN SONNENSCHEIN AND CO. have in the press an important work on the Indian Calendar, written by Mr. Robert Sewell, in collaboration with Mr. Sankara Bâlkrishna Dikshit. The work contains complete tables for the verification of Hindu and Muhammadan dates for a period of 1600 years (A.D. 300 to 1900), and forms an attempt to carry out in practical form the exact fixation of the astronomical phenomena on which the Hindu Calendar depends, and without which no conversion of dates into European reckoning can be safely relied upon. It embraces the whole of India. The calculations have been based on the general tables published by Prof. Jacobi, of Bonn, checked and enlarged by Mr. S. Bâlkrishna Dikshit. The precise position of sun and moon at sunrise on the meridian of Ujjain on the first day of each year of the Luni-solar Calendar during the period referred to is given, and for the Solar Calendar the moment of the sun's passing the first point of Aries in each year is entered in time reckoning. Full details for the addition and suppression of months in the intercalary Luni-solar years are provided; and where necessary the calculations have been made for true as well as mean intercalations. The solar phenomena have, moreover, been computed by both the Ârya and Sûrya Siddhântas. It is hoped that the volume will form a standard work of reference for chronologists, as well as for all courts and offices in India.

THE additions to the Zoological Society's Gardens during the past week include a Giraffe (*Giraffa camelopardalis*, ♀) two Sable Antelopes (*Hippotragus niger*, ♂ ♀) two Brindled Gnus (*Connochætes taurina*, ♂ ♀), a Levaillant's Cynictis (*Cynictis penicillata*) from South Africa, two great Eagle Owls (*Bubo maximus*), European, purchased; two Rock-hopper Penguins (*Eudyptes chrysocome*) from New Zealand, four Black Francolins (*Francolinus vulgaris*) from India, a Robben Island Snake (*Coronella phocarum*) from South Africa, deposited; a Black-headed Gull (*Larus ridibundus*), British, presented by Mrs. Rees Davis; a —— Buzzard (*Buteo*, sp. inc.) from South Africa, presented by Mr. J. E. Matcham; a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by Dr. Arthur D. Bensusan.

OUR ASTRONOMICAL COLUMN.

SPECTROSCOPIC MEASURES OF PLANETARY VELOCITIES.—A new feature in the application of the Doppler-Fizeau principle has been recently brought forward by M. Deslandres (*Comptes rendus*, Feb. 25). It is to the effect that when we observe the spectrum of a body shining by reflected light the displacement of the lines due to movements in the line of sight depends upon the movement of the body with respect to the original source of light, as well as on its movement with regard to the observer.

The truth of this principle is demonstrated by an investigation of the rotation of Jupiter which M. Deslandres has carried out with his usual skill. The equatorial linear velocity of the planet is 12·4 kilometres, and the difference of the velocities of the two extreme edges 24·8 kilometres; actual measurements of the spectrum photographs taken near opposition, however, show a relative movement of twice this amount. The best results appear to have been obtained by allowing the equator of the planet to lie along the slit of the spectroscope, in which case the effect of the displacements at different distances from the centre is obviously to produce an inclination of the lines of the planet spectrum to the lines of the comparison spectrum, and this inclination affords the means of determining the velocities. This method has the advantage that the effects of small movements of the image on the slit during the long exposure necessary with the great dispersion employed are of little consequence; movements in declination will have no effect on the inclination of the lines, and movements in right ascension will only tend to make them somewhat more diffuse.

M. Deslandres points out that the new principle may possibly have many important applications in connection with planetary velocities, among which he specially mentions the determination of the rotation period of Venus, and even possibly of the solar parallax, the latter being derived from the radial velocity of Venus. M. Poincaré shows that M. Deslandres' results are quite in accordance with theoretical considerations.

THE SATELLITES OF MARS.—Prof. Campbell, of the Lick Observatory, took advantage of the recent opposition of Mars to secure a long series of micrometric measurements of the satellites with the 3-foot telescope (*Astr. Journal*, No. 337). The reduction of the observations of Phobos shows that the eastern elongation distance was nearly a second greater than the western, whereas Hall's observations in 1877 showed that the distance at western elongation was then about 2″·2 greater

than the eastern. "If the orbit had remained unchanged from 1877, the western distance in 1894 should have been about 1″·8 greater than the eastern. The change of nearly 2″·8 was evidence of a marked transformation of the orbit during the years 1877-94. The line of apsides has probably revolved owing to a polar compression of the planet." The observations also appear to indicate a similar transformation of the orbit of Deimos, but the evidence is not quite so conclusive.

Both satellites are about 6 minutes behind Marth's ephemeris, so that the adopted values of their periodic times require slight correction.

ECLIPSE OF THE MOON, MARCH 11.—The following particulars with regard to the total eclipse of the moon on the morning of Monday, March 11, may be of interest:—

	G. M. T. h. m.
First contact with penumbra	0 58·4
,, ,, shadow	1 53·9
Beginning of total phase	2 51·8
Middle ,, ,, ...	3 39·2
End ,, ,, ...	4 26 6
Last contact with shadow	5 24·5
,, ,, penumbra	6 20 0

The first contact with the shadow will occur at 127° from the north point of the moon's limb towards the east, and the last contact at 69° towards the west, in both cases for the direct image as seen with the naked eye. The magnitude of the eclipse (moon's diameter = unity) will be 1·619.

The moon will be seen in the shadow at places between longitudes 5h. E. and 12h. W. Among the principal stars occulted during the eclipse will be 83 Leonis, mag. 7 5, which will disappear at 2h. 17m. at an angle of 95° and reappear at 3h. 12m. at an angle of 338°; and τ Leonis, mag. 5·0, which will disappear at 2h. 56m. at 86°, and reappear at 3h. 43m. at an angle of 345°; the angles being reckoned from north towards east.

THE NILE.[1]

I AM to speak to you to-night of the Nile, and I think I may fairly say it is the most famous river in all the world: famous through all the ages, for the civilisation that has existed on its banks; famous for its mystic fabulous rise, about which so many sages and philosophers have pondered; famous for its length, traversing one-fifth the distance from pole to pole; famous, and apparently destined to be famous, for the political combinations that ever centres around it. But I feel I must begin by an apology, for now that Egypt has come so completely within the tourist's range, probably many of my hearers have seen more of the Nile than I have.

If a foreigner were to lecture to his countrymen about the river Thames, and were to begin by informing them that he had never been above Greenwich, he might be looked upon as an impostor; and perhaps I am not much better, for I have never been higher up the river than Philæ, 610 miles above Cairo. For information regarding anything higher up, I must go, like you, to the works of Speke, Baker, Stanley, and our other great explorers. I shall not, then, detain you to-night with any elaborate account of this upper portion of the river, but will only remind you briefly of that great inland sea, the Victoria Nyanza, in extent only a little less than the American Lake Superior, traversed by the equator, and fed by many rivers, some of them taking their rise as far as 5° S. lat. These rivers form the true source of the Nile, the mystery only solved in the present generation.

The outlet of this great lake is on its north shore, where the river rushes over the Ripon Falls, estimated by Speke at only 400 or 500 feet wide, and with a drop of 12 feet. Thence the river's course is in a north-west direction for 270 miles, to where it thunders over the Murchison Falls, a cliff of 120 feet high. Soon after that it joins the northern end of Baker's Lake, the Albert Nyanza, but only to leave it again, and to pursue its course through a great marshy land for more than 600 miles, to where the Bahr Gazelle joins it from the west; a little further down the great Saubat tributary comes in on the east. This is the region in which the river is obstructed by islands of floating vegetation, which, if checked in their course, at last block up its whole width, and form solid obstructions known as *sadds*, substantial enough to be used as bridges, and obstacles, of course, to navigation, until they are cleared away. The waters of the Saubat are of very light colour, and tinge the whole river, which, above its junction, is green and unwholesome, from the long chain of marshes which it traverses. Hence it is called the White Nile. 600 miles further brings us to Khartoum, where the Blue Nile from the Abyssinian mountains joins it, and at 200 miles still further to the north it is joined by the Atbara river, also from Abyssinia, a torrent rather than a river.

Baker gives a graphic account of how he was encamped by the dry bed of the Atbara on June 22, 1861. The heat was intense, the country was parched with drought. During the night the cry went forth that the floods were coming, and in the morning he found himself on the banks of a river, he says, 500 yards wide and from 15 to 20 feet deep. All nature had sprung into life. A little north of the junction of the Atbara is Berber, whence you will remember is the short cut to Suakin in the Red Sea, which so many thought would have been the true route for our Army to take in relieving Gordon. From Khartoum to Assouan is a distance of 1100 miles of river, during which it makes two immense curves, for on a straight line the distance is not half so much, and it is in this part of its course that it passes over the six great cataracts or rapids which block all ordinary navigation. The first or furthest north cataract is just above Assouan, a distance of 750 miles from the Mediterranean, through the country known as Egypt. From the junction of the Atbara to its mouth in the Mediterranean, a distance of 1680 miles, the Nile receives no tributary. On the contrary, during every mile of its course its waters are diminished by evaporation, by absorption, and by irrigation. The river gets less and less as it flows through this rainless land, and its maximum volume is to be found during the floods at the junction of the Atbara, and at other seasons at Khartoum, 1875 miles from the Mediterranean.

The whole distance by river from the Victoria Nyanza to the sea is about 3500 miles. It may not be easy to derive any clear impression from this bare recital of mileage. Let me try to convey to you in some other ways the idea of the length of the Nile. Standing on the bridge at Cairo, I used to reflect that I was just about half-way between the source of the Nile and the White Sea. Or to put it another way: if we could suppose a river crossing our English Channel, and that the Thames should find its outlet in the Euphrates and the Persian Gulf, that river would be about as long as the Nile.

In this short sketch of the course of the Nile, I must not forget to mention one interesting feature. About 40 miles south of Cairo, the low Libyan chain of hills which bounds the Nile valley on the west is broken by a gap, through which the waters of the river can flow, and beyond this gap lies a saucer-shaped depression called the Fayúm, of about 400 square miles in area, sloping down to a lake of considerable size, the surface of whose waters stands about 130 feet below that of the sea. This lake is known as the Birket el Kurún.

From the time of the earliest Egyptian records, this province of the Fayúm was famed for its fertility, and to the Egyptian taste for its delightful climate. Many of the most precious monuments of antiquity have been found in the Fayúm. The famous Labyrinth is supposed to have stood just at its entrance; and what has excited most interest for the engineer in all times, it is here that Herodotus places that wonderful lake Mœris, which receiving for half the year the surplus supply of the Nile, rendered it back again in irrigation to Lower Egypt during the other half. Where this lake actually was, has excited discussion since any attention has been paid to ancient Egyptian history. It seems pretty clear that in earlier days the Birket el Kurún was of much greater proportions than it is now, but how it ever could have been large enough to allow of its waters flowing back into the Nile valley when the river was low, without at the same time drowning the whole Fayúm, is not very clear.

Now, what are the functions of a great river, what are the offices which it renders to man? And first of all, at least in this latitude, we would mention the carrying off to the ocean of the surplus water that descends from the skies. Nobly does the Nile fulfil this duty; but with this enormous qualification, that it transports the water from tracts where there is too much, and carries it all free of cost, not to waste it in the sea, but to

[1] A lecture delivered at the Royal Institution, on January 25, by Sir Colin Scott-Moncrieff.

bestow it on tracts where it is of priceless value, more than taking the place of rain in watering the fields.

The next function of a river is to form a highway through the land, and for most of its course the Nile fulfils this duty well too. Gordon considered it possible for steamers to ascend the Nile during the floods from its mouth to the Fola rapids, a distance of about 3040 miles; but at other seasons, the six cataracts cannot be passed. Leaving out the 1100 miles which they occupy, there is an unbroken 750 miles in the lower, and nearly 1200 miles in the upper river. I cannot look on it as probable that it will ever pay to make navigable canals and locks round these cataracts, as it would entail so much hard rock-cutting.

Another function of a river is to promote industry by the employment of its water-power. We know how valuable is this power even in England, and how much more in countries like Switzerland, where it abounds. and on the great rivers of America. Excepting a few very rude wooden wheels in the Fayûm, I do not know, through all the annals of the past, of a single water-wheel ever turned by the power of the Nile. But that power exists to an almost unlimited extent. And may we not prophesy that some day in the future, when that long stretch of Nubian cataracts has fallen into civilised hands, and when we know how to transmit electric energy with economy, that then our descendants will draw wealth to Egypt from its chain of barren cataracts?

As a drainage outlet to a continent, as a long highway, as a source of power, the Nile is great; but not so much so as many other rivers. Its unique position is due to the benefit it confers on Egypt in turning it from being a desert into being the richest of agricultural lands, supporting with ease a population of about six hundred to the square mile. Herodotus truly said Egypt is the gift of the Nile. It more than supplies the absence of rain, and this it does, first, by the extraordinary regularity with which it rises and falls; and secondly, by the fertilising matter which the waters carry in suspension, and bestow upon the land. Imagine what it would be to the English farmer if he knew exactly when it would rain and when it would be sunshine. When the Irrigation Department of Egypt is properly administered, the Egyptian farmer possesses this certainty, and he has this further advantage—that it is not merely water that is poured over his lands, but, during nearly half the year, water charged with the finest manure.

According to the early legend, the rise of the Nile is due to the tears shed by Isis over the tomb of Osiris, and the texts on the Pyramids allude to the night every year on which these tear-drops fall. The worship of Isis and Osiris has long passed away, but to this day every native of Egypt knows the *Lailet en Nuktah*, the night in which a miraculous drop falls into the river, and causes it to rise. It is the night of June 17. Herodotus makes no allusion to this legend of Osiris. In his time, he says, the Greeks gave three reasons for the river's rise. He believed in none of them, but considered, as the most ridiculous of all, that which ascribed the floods to the melting of snows, as if there could possibly be snows in such a hot region. It was many centuries after Herodotus' time when the snowy mountains of Central Africa were discovered.

The heavy rains commence in the basin of the White Nile during April, and first slowly drive down upon Egypt the green stagnant waters of that marshy region. These appear at Cairo about June 15. About a fortnight later the real flood begins, for the rains have set in in Abyssinia by May 15, and the Blue Nile brings down from the mountains its supply of the richest muddy water. It is something of the colour and nearly of the consistency of chocolate, and the rise is very rapid, as much sometimes as 3 feet per diem, for the Atbara torrent having saturated its great sandy bed, is now in full flood also. The maximum flood is reached at Assouan about September 1, and it would reach Cairo some four days later, were it not that during August and September the water is being diverted on to the land, and the whole Nile valley becomes a great lake. For this reason the maximum arrives at Cairo about the beginning of October. The rains cease in Abyssinia about the middle of September, and the floods of the Blue Nile and Atbara rapidly decrease; but in the meantime the great lakes and marshes are replenished in the upper regions, and slowly give off their supplies, on which the river subsists, until the following June. Yearly this phenomenon presents itself in Egypt, and with the most marvellous regularity. A late rise is not more than about three weeks later than an early rise. In average years the height of the flood at Assouan is about 25½ feet above the minimum supply. If it rises 29 feet above this minimum, it means peril to the whole of Egypt, and the irrigation engineer has a hard time of it for two months. If the river only rises 20 feet above the minimum, it means that whole tracts of the valley will never be submerged. Such a poor flood has happened only once in modern times, in 1877, and the result was more serious than the devastation caused by the most violent excess.

The mean flood discharge at Cairo is about 280,000 cubic feet per second, the maximum about 400,000. The mean lowest Nile is about 14,000 cubic feet per second at Cairo, but some years there is not more than 10,000 cubic feet per second passing Cairo in June, and within three months after this may have increased forty-fold.

Until this century, the irrigation of Egypt only employed the flood waters of the river, and it was this that made it the granary of the world. No doubt, rude machines for raising Nile water were used at all seasons and from all times. But by these it was not possible to irrigate on a large scale, and in reality they were only employed for irrigating vegetables or gardens, or other small patches of land. It must not be thought that the water of the flooded river is ever allowed to flow where it lists over the lands. The general slope of the valley on each side is away from the river, a feature which the Nile shares with all Deltaic streams. Along each edge of the river, and following its course, is an earthen embankment, high enough not to be topped by the highest flood. In Upper Egypt, the valley of which seldom exceeds six miles in width, a series of embankments have been thrown up, abutting on their inner ends against those along the river's edge, and on their outer ends on the ascending sides of the valley. The whole country is thus divided into a series of oblongs, surrounded by embankments on three sides, and by the slope of the desert hills on the fourth. In Lower Egypt, where in ancient days there were several branches of the river, this system was somewhat modified, but was in principle the same. These oblong areas vary in extent from 60,000 to 3000 or 4000 acres, and the slope being away from the river, it is easy to cut short, deep canals in the banks, which fill as the flood rises, and carry the precious mud-charged water into these great flats, or, as they are termed, basins of irrigation. There the water remains for a month or more, some three or four feet deep, depositing its mud, and then at the end of the flood it may either be run off direct into the receding river, or, more usually, passed off through sluices from one basin to another, and ultimately back into the river. In November the waters have passed off, and wherever a man and a pair of bullocks can walk over the mud, and scratch its surface with a wooden plough, or even the branch of a tree, wheat or barley is sown, and so saturated is the soil that the grain sprouts and ripens in April or May without a drop of rain or any fresh irrigation. And a fine crop is reaped. One of our great brewers told me the other day, that when barley grown in this country was spread in the malting-house, about three per cent. of it must be counted on as not sprouting and being dead. If grain two or three years old was used, as much as twenty per cent. would be found dead. With Egyptian barley, he said, even after several years, you could count on every grain germinating. The crop once reaped, the fields remain dry, and crack in the fierce summer heat until next flood comes on.

The tourist who only comes to Egypt to shun "winter and foul weather," knows nothing of the majestic glories of the Nile flood. The ancient Nilometer at the south end of the island of Roda, just above Cairo, is one of the most interesting sights of the place. The water enters from the river by a culvert into a well about 18 feet square, with a graduated stone pillar in the centre. On each side of the well is a recess about 6 feet wide and 3 feet deep, surmounted by a pointed arch, over which is carved in relief a Kufic inscription, and a similar inscription is carried all round the well, consisting of verses of the Koran. A staircase goes down the well, from the steps of which the initiated may read the height of the water on the pillar; but they are few in number, and the hereditary Sheikh of the Nilometer, whose duty it is to keep the record, is a person of some importance. The Nilometer dates from A.D. 861, and I believe in the archives of Cairo may be found the daily record for 1000 years.

I need hardly tell you that when our English engineers took the river in hand, we established a number of gauges at Wadi Halfa, Assouan, Cairo, and many other points, on more scientific principles than the venerable Nilometer of the Roda Island.

After the river has begun to rise, its height is daily chanted

through the Cairo streets until it reaches 16 cubits on the gauge. At this point the Khalig el Masri, the old canal that flows through the heart of Cairo, is opened—up to this point it is dry, and full or empty it is little more than a sanitary abomination at present; but in former days it occupied an important place, and when the Nile water was high enough to flow down its bed, it was looked on that the flood had fairly set in, and that the kindly fruits of the earth might be duly expected.

The head of this canal is on the right bank of the river, just south of Cairo. The water enters a channel some 30 feet wide, with a high wall on its left, and a sloping bank on its right or southern flank. The water then flows under the pointed arch of an old stone bridge. The bed of the canal is cleared so that it would flow in at a gauge of about 14½ cubits, but an earthen bank is thrown across it about 4 feet higher.

There is no more interesting ceremony in Egypt than the annual cutting of the Khalig, as the opening ceremony is called. It takes place between August 5 and 15. Days before preparations are being made for the festival. Tents with innumerable lamps are placed along the wall on the one side. Frames for all manner of fireworks are erected on the sand-bank on the other side. All the notables are there in full uniform, or in canonicals. The Khedive himself, or his representative, the Sheikh ul Islam (the highest dignitary of the Muhammedan faith), the Sheikh el Bekri, the Sheikh es Sadát, all the learned scribes of the great university of the Azhár, the Cabinet Ministers and Under-Secretaries, the Sirder of the Army and his staff, the Judges, and the Financiers.

The Egyptian troops are turned out, salutes are fired, and about eight o'clock in the warm summer night the classes all assemble under the gaily-lighted tents, the masses crowd round the frames for the fireworks, the street is lined with harem carriages full of closely-veiled figures, though it is not much that they can see from their broughams. Out in the river, just opposite the canal's mouth, is moored an old hulk of a certain sea-going outline, which has been towed up from Boulak during the day, and is an emblem of the time when the great republic of Venice sent an envoy to witness the ceremony. This boat is full of lamps, and fireworks too. As the night deepens the excitement increases. The populace on the bridge and the opposite bank are shouting, yelling, and dancing wildly round the fireworks. On the other side are the gay uniforms and lighted tents, from whence we can look over the wall down on the dark water, where you see brown figures plunging in and waist-deep digging with their hoes at the embankment that blocks the canal's mouth.

Long before midnight the fireworks have gone out, and left the splendid stars to themselves; the grandees have all gone to bed, but the people keep up the revelry, and in the morning, by 7.30, every one has come back. Then but little of the bank is left uncut; a few more strokes of the big hoes will do it, and the brown skins and the brown water reflect the bright sunlight from above. Then the Sheikh ul Islam solemnly thanks the Almighty, Allah the All-powerful, the All-merciful. He implores His blessing on the flood, and at a signal the bank is cut, the waters rush in, and with them a crowd of swimmers. A bag of silver piastres is scattered among them, and the ceremony is at an end.

There is a pretty legend, worth telling, of the cutting of the Khalig. Amr, the Muhammedan General, took Cairo in A.D. 640. Long before then there had been a heathen ceremony, and a virgin was yearly sacrficed to the god of the river. When the season came round, Amr was called upon as usual to sacrifice the girl. He sternly refused. That year the Nile flood was a failure. You can fancy how the indignant heathen population must have raged at the invader, and said, "We warned you what would happen if you didn't propitiate the river god." Cannot we fancy, also, how Amr's wild Arab soldiers must have had their faith sorely tried, and how they must have felt puzzled as to whether in this strange new country, with all those demon-built temples and pyramids, obelisks and sphinxes, it might not be as well to make friends of the local gods. Could Allah really help them here? Again the Nile flood came round. This time surely Amr would sacrifice the girl, and save the land. No; he would not. The people rose in rebellion. Amr stood firm. But he wrote to the Kalif Omar for orders (Omar, whose name you will remember has come down in history as the destroyer of the Alexandrian library). Omar approved of his conduct, but sent him a paper to throw into the Nile. On the paper was written, "From Abd Allah Omar, Prince of the Faithful, to the Nile of Egypt. If thou flow of thine own accord, flow not; but if it be Allah, the one the mighty, who causeth thee to flow, then we implore him to make thee flow." Amr threw the paper into the water, and the Nile rose forthwith exactly as it was wanted. Since that day no girl has been sacrificed; but a pillar of earth is yearly left to be washed away in the middle of the canal, called the bride or the girl.

Such, as I have briefly described it, was the irrigation of Egypt until this century, when it fell under the rule of Muhammed Ali, a very sagacious and strong if a very unscrupulous ruler. He saw that the country could produce far more valuable crops than cereals. The European market could be supplied with these from the fields of Europe, but Europe could not produce cotton and sugar-cane. Egypt had the climate, had the soil, had the teeming population; but these crops required water at all seasons; nor would it do to flood the fields to any depth, for just at the flood season the cotton crop is ripening. There was plenty of water in the river; but how was it to be got on to the land? Perennial irrigation was a fresh departure. As I have said, the Nile rises about 25½ feet. A canal then running 12 feet deep in flood has its bed 13½ feet above the surface of the Low Nile. Either the Nile water had to be raised, or the beds of the canals had to be lowered, in order that one should flow into the other, and after that the water had to be raised from the canal on to the land. Muhammed Ali began by lowering the canal beds of Lower Egypt, an enormous work considering the great number of the canals; and as they had been laid out on no scientific principles, but merely to suit the fancies of Turkish pashas or village sheikhs, and as those who had to excavate them to this great depth had only the slightest knowledge of levelling, the inevitable result followed—the deep channel became full of mud during the flood, and all the excavation had to be done over again. Incredible as it may seem, this great work was done year after year. It was a great serf population; if they were not fighting Muhammed Ali's battles in Arabia and Syria, they might as well be digging out the canals. No one thought of paying or feeding the workmen. The bastinado was freely applied if they attempted to run away. If they died under the labour, there were plenty more to come. But of course the work was badly done. The water might enter the canal; but as the bed was not truly levelled, it did not follow that it would flow far. Then, as the river daily fell, the water in the canals fell too, and lessened in volume as the heat increased, and more was required. At last—in June, perhaps—the canal was dry, and the cotton crop that had been sown and watered, weeded and nurtured, since March, was lost altogether.

Then some one advised Muhammed Ali to throw a dam across the river, and so raise the water, and the result was the great Barrage.

About twelve miles north of Cairo the Nile bifurcates, and finds its way to the sea, by the Rosetta and Damietta branches. Across the heads of these two branches were built two stone bridges, one of 71, the other of 61 arches, each 5 metres or 16·4 feet span. These arches were intended to be fitted with gates; by lowering which, all the water would be dammed up, and diverted into three great trunk canals, taken out of the river just above these bridges. One to the right or east of the Damietta branch was to supply water to all the Provinces of the Eastern delta, one between the two bridges was to supply the splendidly fertile central delta, the third to the left or West of the Rosetta branch was to water all the Western delta down to Alexandria.

There was no intention of water storage at the Barrage, but it was merely with the object of controlling the supply. While there was water enough in the river, by closing the gates it could be kept to a uniform level, and sent down the three trunk canals, from which it was to branch, into many minor ones. As the river went down, gate after gate would be closed, and so a constant supply could be kept in the canals. The idea was thoroughly sound. The execution was feeble.

Mougel Bey, the French engineer in charge of the work, had no doubt many difficulties to contend with. The work went fitfully on for many years, thousands of men being forced to it one year, and carried off to a campaign the next. But at last it was sufficiently finished to allow of an opening ceremonial in 1861. Gates had been fitted into the Rosetta branch arches, never into the Damietta.

The Central canal had been dug in tolerably satisfactory style. The Western canal, too, had been dug, but passing through a strip

of desert it had become very much filled up with sand. The Eastern canal was dug some five miles, and then stopped. Of course the Barrage without these canals was useless. However, they began to experiment with it, closing the gates on the Rosetta side. It was intended to hold up 4½ metres, or 14 feet 9 inches of water. It never held up 5 feet, till in 1867, it cracked across from top to bottom, on the Western side. An immense coffer-dam was built round the cracked portion, and the water was never held up again more than about 3½ feet, while the work was looked on as a deplorable failure. In 1883, all hope of making anything out of the Barrage was abandoned, and the Government were on the point of concluding a contract with a company to supply Lower Egypt with irrigation by means of an immense system of steam pumps, to cost £700,000 to begin with, and £250,000 a year afterwards.

That year there was a wretched serf army of 85,000 men working at canal clearances for 160 days, unfed, unpaid. The burden was nearly intolerable. The irrigation was all by fits and starts. There was no drainage; every hollow became sour and water-logged. With waterways everywhere, there was no navigation. In Upper Egypt things were better, as the system was a simpler one. But when we came to look into them too, we found great abuse, and on an average about 40,000 acres never succeeded in obtaining water, though in the midst of abundance.

The Fayúm had long been a much-neglected province, though a most picturesque and attractive one. From carelessly allowing Nile water to flow into the lake during the floods, it had risen enough to swamp 10,000 acres of valuable land, and this mischief we found still increasing.

Throughout the whole country drainage had been absolutely neglected. And here I would point out that irrigation without drainage means the sure deterioration of the land sooner or later. Considerable pains had been taken in Egypt to get the water on to the land. No sort of effort had been made to get it off. In a properly irrigated tract, between every two canals of supply, there should flow a drainage channel; the former should follow as far as possible the highest lands, the latter should follow the lowest. The canal gets smaller, till at last it is exhausted, giving itself out in innumerable branches. The drain, like a river, gets larger as it proceeds, being constantly joined by branches. But if there be no drains, and if the canals are laid out to flow into one another, so as to divide the country into, as it were, a cluster of islands, you can understand how the drainage water has no means of flowing off into the sea, and settles in unwholesome swamps. These we found prevailing to an alarming extent in the rich provinces of the delta. Such was the wretched state of Egyptian agriculture—the one single source of the country's wealth—when Lord Dufferin laid down the lines of the English administration, which have been amplified and pursued ever since.

It was in May, 1883, that I took charge of the irrigation department in Egypt, having before then had some twenty years' experience of similar work in India; and I soon had the inestimable advantage of being joined by a band of the most indefatigable, energetic and able engineers, also from India, with whom it was my great privilege and happiness to be associated for the next nine years. I cannot talk too highly of these my colleagues—men who knew their work and did it, who kept constantly moving about in the provinces, badly lodged, badly fed, denied domestic comforts, constantly absent from their wives and families (they were all married men).

My friends, happy is the reformer who finds things so bad that he cannot make a movement without making an improvement. Happy the reformer who has as colleagues a staff of thoroughly loyal, duty-doing and capable men. Happy the reformer who is not pestered on all sides by the officious advice of the ignorant. Happy the reformer who has behind him a strong brave chief, as honest and truthful as he is strong. Such rare happiness fell to me in Egypt with my noble colleagues, and with Lord Cromer as our chief.

It is not my intention to enter into any details to-night of what our work was in Egypt. I have lately spoken about that elsewhere, and there would be no time to do so now. I must just describe it generally.

On first arrival, I was pressed, both by English and French men, to go into the question of the storage of the flood waters of the river on a large scale. I declined to do so, considering it would be time enough to think of increasing the quantity of water at our disposal when we had profitably used all that we already had, and while mighty volumes were daily flowing out to the sea, it could not be said that we were doing that. The first great work to be studied was the Barrage. We were warned on all sides to have nothing to say to it, as it was thoroughly unsound; but we felt sure we must either make it sound or build an entirely new one, and we resolved on the former. The work had failed because it was faulty in design, the floorings and foundations not being sufficiently massive, and faulty in execution from the dishonest use of bad materials and from bad workmanship. The bed of the river consists of nothing more stable than sand and alluvial mud for at least 200 feet deep. It was out of the question to think of getting down to solid rock. It was not, as we thought, very safe to excavate very deeply close to the existing works, so we decided not to try it, but merely to strengthen and consolidate the foundations, built as they were on sand. I have said that the work consisted of two great bridges over the two branches of the river. We could not shut up either branch entirely; but we decided to strengthen and complete one-half of each bridge each season, which meant four seasons' work. While the river was still in considerable flood each November, we began to throw out great embankments of earth about 200 feet from the bridge; one up-stream, the other down-stream of it, beginning at the shore end, and ultimately enclosing one half of the river as in a pond. This used to take three months' hard work. Then we pumped the water out of this enclosure, and laid bare the very bed of the river. Then we laid a massive stone flooring, 5½ feet thick, extending 100 feet up-stream, and as much down-stream, of the bridge. This was very difficult and hard work. It was kept going day and night, without intermission, from March till the end of June. Then we cut great holes in our embankments, cleared out our machinery, and prepared for the arrival of the flood at the beginning of July. Each year one-half of one bridge was finished, and the whole was completed at the end of June 1890.

In connection with the Barrage were completed the three great canals to carry off all the river supply from above it. So that practically now the Low Nile is emptied every season at the Barrage and diverted into these canals, and no water at all escapes to the sea. The natives wade everywhere across the river north of this point. Since it was completed the Barrage has given no trouble. It holds up every year 4 metres, or 13 feet of water. The three trunk canals were all supplied with locks 160 feet by 28 feet, and adapted for navigation. The whole of these works cost about £800,000. The annual increase of the cotton crop, compared to what it was before 1884, is never less than two and a half millions sterling, which has not been a bad investment for Egypt.

Turning to Upper Egypt, my colleague, Colonel Ross, directed his attention very closely to the adjustment of canals overlapping one another, passing under and passing over one another; so that in future I trust that with the feeblest Nile flood it will be possible to pour water over every acre of the land.

The question of drainage was very thoroughly taken up. Twelve years ago it may be said that there were no drainage channels in Egypt. Two years ago there were about 1000 miles of such channels, some with beds as wide as 60 feet and flowing deep enough to carry cargo boats, others with beds only 3 or 4 feet wide. I am glad to say by these means large tracts in Lower Egypt which had been abandoned as totally ruined have now been restored to cultivation. The level of the lake in the Fayúm was reduced by 13 feet between 1885 and 1893, and most of the inundated lands around it have been again dried.

I have already mentioned the cruel hardship of the corvée, the serf army of 85,000 men who were employed in the canal clearances from January to July, nearly half the year. I believe this institution was as old as the Pharaohs, and it was not easy to abolish it. But of course it went sorely against our British grain. Little by little we got money to enable us to pay our labour. By an annual outlay of £400,000 this spring corvée has entirely ceased since 1889, and now the Egyptian labourer carries out these clearances in as free a manner as his brother in Middlesex, and gets paid for his work.

Having thus, to the best of our powers, utilised the water in the river flowing past us, we turned our attention to the storage of the surplus waters. Without some such storage it is impossible to increase the cultivation during the Low Nile. All the water is used up. During High Nile there is always a great volume escaping useless to the sea.

There are two ways in which the water may be stored; either by throwing a dam right across the river and forming a great lake above it, or, if such a place can be found, by diverting the flood water into some suitable hollow, and drawing it off from there at the season of low supply, as done by Herodotus' celebrated Lake Mœris. At one time there was a hope that such a storage basin might be found. An American gentleman, named Mr. Cope Whitehouse, in search of the real Mœris, found a very remarkable saucer-shaped depression just south of the Fayûm. We knew it could not have been Mœris, because in its bed we found no traces of a deposit of Nilotic mud, but it might be possible all the same to utilise it. The place was very carefully surveyed, and the project was estimated; but it was found that the cost of conveying the water into this basin would be so great that it was out of the question.

Attention was then turned to the possible sites where a stone dam might be built right across the river. The southern boundary of Egypt just now is near Wady Halfa, the second cataract. It is no use going to look for sites south of this, for the country is in the hands of the Mahdi and his fierce dervish soldiers. North of this point, unquestionably the best site, perhaps the only possible site is where the Nile valley is traversed by a broad dyke of hard Syenite granite, in passing over which the river forms its first cataract just south of Assouan. It is here divided into several channels between rocky islands, and no channel is deep, so that it would be easy to divert the water from one after another, to lay bare the bed of the river, and lay the foundations of the dam in the open air. It wants no engineer to understand what an advantage this is.

And the great dam, such as was designed by Mr. Willcocks, would have been a work worthy of the land of the Pyramids and Karnak—a great wall of squared granite blocks—82 feet thick at base, of a maximum height of 115 feet, 1¼ miles long, pierced by sluices large enough to allow of the whole Nile at highest flood rushing through. The lake formed would have been 120 miles long. Would this not have been a work of some majesty to commemorate for ever the English rule in Egypt—a work one would have been proud to have had a hand in? But it was not to be. The Egyptian saw no objection to it. The money could have been found. But there was an insuperable obstacle created when, on the Island of Philæ, about 250 B.C., Ptolemy II. built a temple to Isis, on the site of older buildings long disappeared. Round this temple other buildings clustered, built by Greeks and Romans. Those of you who have not seen them, are probably familiar from pictures with the group of venerable buildings standing amidst palm trees on the rocky island, and reflected in the waters below.

Had Ptolemy only built his temple on the island of Elephantine, a few miles north, it would have been unaffected by the great dam, but Philæ is just to the south, or up-stream side of where the great dam must necessarily have come, and in consequence the island, with its temples, would be drowned for about six months every year. You probably remember the outburst of rage and indignation which the announcement of this proposed desecration created in London last summer. It was not to be tolerated that England should commit such vandalism. In vain it was answered that the place belonged to Egypt, not to England—that the Egyptian, who was to gain so much by the dam, cared absolutely nothing about Ptolemy and his temples—that he was prepared to pay a large price for a great work to benefit his country. What business was it of England to forbid him?

And it was not only the English who were indignant. For once, and only for once, I fear, since we occupied Egypt in 1882, was educated opinion in England and France at one. Both alike insisted that Philæ should not be drowned. Nor must I admit had all the engineers that were interested in the question the full courage of their opinions. While they longed to build the dam, and lamented the perverse fate that had put Philæ there, still they wished to spare Philæ—and their voice has prevailed. The majestic structure has been cut down 27 feet, and now will only be 88 feet high, and Philæ will stand henceforth in a lake, but will never be drowned.

Personally I accept the situation, for I never believed that it would be sacrificed. But yet as an engineer, I must sigh over the lost opportunity for England of making such a splendid reservoir. And as a friend to Egypt, I sigh still more that the country will not have such a splendid supply of water as would enable Upper Egypt to have the full benefits now possessed by Lower Egypt, and Lower Egypt to expand and flourish.

The reduced scheme will, however, be a great boon to the country, and I trust will now be put in hand without delay.

In 1884, when the expedition up the Nile was first being considered, I was asked by the General Officer commanding in Egypt, whether I thought there was any possibility of the Mahdi diverting the river in the Soudan, and depriving Egypt of its water. The late Sir Samuel Baker was in Cairo at the time, and I consulted him as to whether he knew of any place in the Nile valley where during highest flood the water spills off to the right or left, towards the Red Sea or the Libyan Desert. He said he was sure there was no such place, and I then told the General it would be impossible for the Mahdi to divert the Nile. I was sure that with his savages he would never dam up the low supply until its surface attained the height of flood supply, and if even then during flood there was no spill channel, Egypt was safe enough.

But what the Mahdi could not do, a civilised people could do. A Government official has no business to talk politics, and the Royal Institution is no place for politics; but I may be allowed to point out an evident enough fact, that the civilised possessor of the Upper Nile valley holds Egypt in his grasp.

At this moment the Italians are on the eastern edge of that valley—a nation, I must say, who have been consistently most friendly to us in Egypt. Supposing that they occupied Khartoum, the first thing they would naturally and very properly do would be to spread the waters of the Low Nile over the Soudan; and no nation in Europe understands irrigation so well. And what then would become of Egypt's cotton crops? They could only be secured by a series of the most costly dams over the river, and the fate of Philæ would surely be sealed. But more than this: a civilised nation on the Upper Nile would surely build regulating sluices across the outlet of the Victoria Nyanza, and control that great sea as Manchester controls Thirlemere. This would probably be an easy operation. Once done, the Nile supply would be in their hands; and if poor little Egypt had the bad luck to be at war with this people on the upper waters, they might flood them, or cut off their water supply at their pleasure.

Is it not evident, then, that the Nile from the Victoria Nyanza to the Mediterranean should be under one rule? That time is perhaps far off. I conclude what I have to say to-night, by giving you the assurance, and I challenge contradiction, that at no time in the long history of Egypt under Pharaoh or Ptolemy, Roman or Arab, or Turk, have the people of the country been so prosperous, or so justly ruled as during the last nine years.

OBSERVATIONS OF SUN-SPOT SPECTRA.[1]

I. *The Widening of Iron Lines and of Unknown Lines in Relation to the Sun-spot Period.*

IT is now twenty-eight years since I discovered that the lines seen in sun-spots were subject to widening,[2] and that different lines were widened at different times.

It was not, however, till 1879 that I was enabled to commence daily routine work of such a nature that all observations were comparable *inter se*. This desideratum was secured by limiting attention to the twelve lines most widened between F and D.

In 1886[3] I gave an account of some of the early results obtained by this research. I have recently commenced the complete discussion of the whole series of observations to the present year.

This discussion, involving 21,000 lines widened during the period in question, has necessitated three special researches: the first, dealing with the lines with which, contemporaneously, coincidences have been found in the laboratory; the second, dealing with those the origin of which is so far unknown; and the third, with the distribution of both sets of lines in spots in relation to the sun-spot period.

To make the work as definite as possible, I am, in the first instance, confining the inquiry concerning the known lines to lines of iron based upon the examination of the pure electrolytic iron referred to in a previous communication.

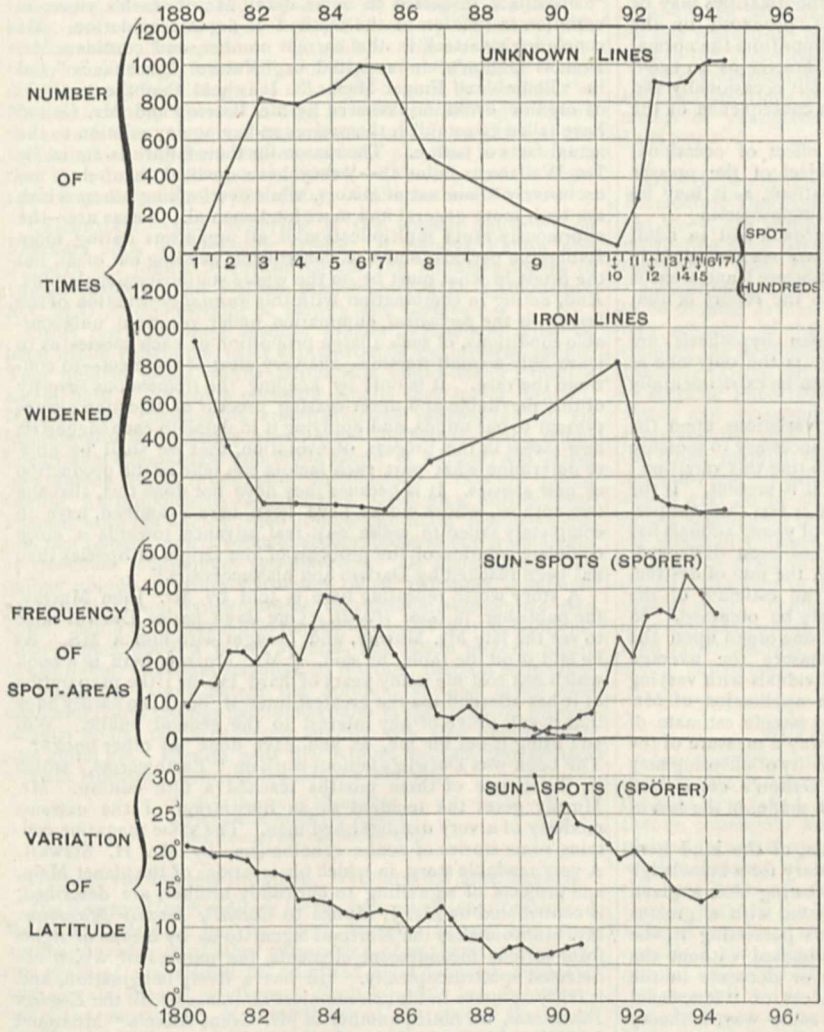
[1] A Paper read at the Royal Society, by J. Norman Lockyer, C.B., F.R.S.

[2] "Roy. Soc. Proc." vol. xv. p. 256, 1866.

[3] "Roy. Soc. Proc." vol. xl. p. 347.

[4] "Roy. Soc. Proc." vol. liv. p. 359.

The following statistics will show the relation of these iron lines to the Fraunhofer lines in the region F—D over which the spot work extends. In the table, "terrestrial lines" means lines which have been photographically recorded by myself or my assistants in the spectrum of some metal or another during the past twenty-four years; "unknown" means a line not so far traced by me in any metal with the exception of Cerium. This exception is necessitated by the fact that the spectrum of that metal contains practically as many lines as appear in the solar spectrum. The wave length map of Rowland's second series has been taken as a standard.



Region.	Fraunhofer lines.	Terrestrial lines.	Unknown lines.	Iron lines.
F				
4861—4900...	92	41	51	16
4900—5000...	175	96	79	45
5000—5100...	228	92	136	33
5100—5200...	176	92	84	39
5200—5300...	165	83	82	32
5300—5400...	211	76	135	29
5400—5500...	216	63	153	26
5500—5600...	186	57	129	31
5600—5700 ..	149	73	76	29
5700—5800..	198	48	150	22
5800—5895...	208	31	177	5
D				
	2004	752	1252	307

In the present communication I confine myself to submitting provisional curves based upon a preliminary inquiry into the number of times the lines of both categories have been observed to be widened in spots. Some slight corrections will, doubtless, be ultimately required when a few uncertainties connected with some of the earlier observations, made before Rowland's maps were available, have been cleared up. The highest points of the curves represent the maximum frequency of iron lines in one case and of unknown lines in the other.

The period embraced by the observations practically enables us to study what has taken place at two successive sun-spot minima and two maxima. It will be seen that the phenomena which followed the minimum of 1879 have been exactly reproduced after the minimum of 1890. At the minima the iron lines are prominent among the most widened lines; at the maxima we only find lines about which nothing is known. Since the discussion indicates that the iron lines involved, which ultimately disappear, are almost invariably those seen most prominent in the spark, the view put forward in my paper of 1886 that the change observed is due to the dissociation of iron in the spots as a sun-spot maximum is approached, is corroborated, and, so far, I have heard of no other simple and sufficient explanation.

It will be noted that the maxima and minima of solar temperature thus revealed to us, if my hypothesis be confirmed, lag behind the spot maxima and minima. This may explain the lag observed in those meteorological conditions, the secular changes in which have been held by Balfour Stewart, Broun, Meldrum, Blanford, Chambers, and others, to prove that the disturbances and changes in our own atmosphere are affected by those taking place in the atmosphere of the sun.

VARIATION IN ANIMALS AND PLANTS.[1]

THE importance of variation as a factor in organic evolution is not seriously disputed; but, if one may judge from the expressions contained in recent essays, naturalists are not agreed as to the manner in which variation among individuals is associated with specific modification.

The view originally put forward by Darwin and Wallace is that specific modification is at least generally a gradual process, resulting from "the accumulation of innumerable slight variations, each good for the original possessor" ("Origin of Species," chap. xv.). This view rests on the assumption that each of those small differences which are to be observed among a group of individuals belonging to the same species has generally some effect upon the chance of life. "Can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage, however slight, over others, would have the best chance of surviving and of procreating their kind?" ("Origin of Species," chap. iv.).

Of late years, another view has received support from various writers. An examination of any series of animals of the same species preserved in a museum shows in most cases a large majority of specimens which are superficially alike: those individual differences, upon which stress is laid by Darwin and by Wallace, are often so slight as to escape attention unless minute comparison is made between individual and individual.

[1] A paper read at the Royal Society on February 28, by Prof. W. F. R. Weldon, F.R.S.

But there will commonly be found a few individuals which differ so remarkably from their fellows as to catch the eye at once. Such large deviations differ from the smaller ones, at least in most cases, by their extreme rarity; but they have been extensively collected, and most museums contain numerous examples of their occurrence. Some naturalists have been led, from the striking character of such variations, to assume for them a preponderant share in the modification of specific character. These persons assume, if I understand them rightly, that the advantages or disadvantages which accompany the more frequent slight abnormalities are in themselves of necessity slight; and that the effect of such slight abnormalities may be neglected, in comparison with the effect produced by the occasional appearance of considerable deviations from the normal type. They regard change in specific character as an event which occurs, not slowly and continuously, but occasionally and by steps of considerable magnitude, as a consequence of the capricious appearance of "sports."

Without presuming to deny the possible effect of occasional "sports" in exceptional cases, it is the object of the present remarks to discuss the effects of small variations, as it may be deduced from the study of two organs in a single species.

The case chosen is the variation, during growth and in adult life, of two dimensions of female *Carcinus mænas*, recently investigated by a Committee of the Royal Society; and what is here said may be considered an appendix to the report of that Committee.

The questions raised by the Darwinian hypothesis are purely statistical, and the statistical method is the only one at present obvious by which that hypothesis can be experimentally checked.

In order to estimate the effect of small variations upon the chance of survival, in a given species, it is necessary to measure *first*, the percentage of young animals exhibiting this variation; *secondly*, the percentage of adults in which it is present. If the percentage of adults exhibiting the variation is less than the percentage of young, then a certain percentage of young animals has either lost the character during growth or has been destroyed. The law of growth having been ascertained, the rate of destruction may be measured; and in this way an estimate of the advantage or disadvantage of a variation may be obtained. In order to estimate the effect of deviations of one organ upon the rest of the body, it is necessary to measure the average character of the rest of the body in individuals with varying magnitude of the given organ; and by the application of Mr. Galton's method of measuring correlation, a simple estimate of this effect may be obtained. In the same way a measure of the effect of parental abnormality upon abnormality of offspring may be numerically measured by the use of Galton's correlation function, and such measurements have been made, in the case of human stature, by Mr. Galton himself.

It is to be observed that numerical data, of the kind here indicated, contain all the information necessary for a knowledge of the direction and rate of evolution. Knowing that a given deviation from the mean character is associated with a greater or less percentage death-rate in the animals possessing it, the importance of such a deviation can be estimated without the necessity of inquiring how that increase or decrease in the death-rate is brought about, so that all ideas of "functional adaptation" become unnecessary. In the same way, a theory of the mechanism of heredity is not necessary in order to measure the abnormality of offspring associated with a given parental abnormality. The importance of such numerical statements, by which the current theories of adaptation, &c., may be tested, is strongly urged.

The report itself describes an attempt to furnish some of the numerical data referred to for two dimensions of the shore crab. The data collected give an approximation to the law of frequency with which deviations from the average character occur at various ages. The conclusions drawn are (*a*) that there is a period of growth during which the frequency of deviations increases, illustrating Darwin's statement that variations frequently appear late in life; (*b*) that in one case the preliminary increase is followed by a decrease in the frequency of deviations of given magnitude, in the other case it is not; and that (*c*), assuming a particular law of growth (which remains, as is admitted, to be experimentally tested), the observed phenomena imply a selective destruction in the one case, and not in the other.

It is not contended that the law of frequency at various ages, adopted in the report, is exact. It is, however, hoped that the approximation is sufficiently exact to give numerical estimates of the quantities measured, which are at least of the same order as the quantities themselves, and for this reason it is hoped that the method adopted may prove useful in other cases.

SCIENCE IN THE MAGAZINES.

IN the February number of the *Fortnightly*, Dr. A. R. Wallace discussed in some detail Mr. Bateson's views on variation in relation to the method of organic evolution. He concludes his attack in the current number, and considers Mr. Francis Galton's views, stated in "Natural Inheritance" and in "Thumb and Finger Marks." It is held that the methods of organic evolution favoured by Mr. Bateson and Mr. Galton have failed to establish themselves as having any relation to the actual facts of nature. The reason for their failure is stated by Dr. Wallace as follows:—"they have devoted themselves too exclusively to one set of factors, while overlooking others which are both more general and more fundamental. These are—the enormously rapid multiplication of all organisms during more favourable periods, and the consequent weeding out of all but the fittest in what must be on the whole stationary populations. And, acting in combination with this *annual* destruction of the less fit, is the *periodical* elimination under recurrent unfavourable conditions, of such a large proportion of each species as to leave only a small fraction—the very elect of the elect—to continue the race. It is only by keeping the tremendous severity of this inevitable and never-ceasing process of selection always present to our minds, and applying it in detail to each suggested new factor in the process of evolution, that we shall be able to determine what part such factors can take in the production of new species. It is because they have not done this, that the two authors, whose works have been here examined, have so completely failed to make any real advance towards a more complete solution of the problem of the Origin of Species than has been reached by Darwin and his successors."

A story worth repeating here is told by Mr. John Murray, the publisher, in *Good Words*. One day Charles Darwin came to see the late Mr. Murray, and brought with him a MS. As he laid it on the table, he said, "Mr. Murray, here is a book which has cost me many years of hard labour; the preparation of it has afforded me the greatest interest, but I can hardly hope that it will prove of any interest to the general public. Will you bring it out for me, as you have done my other books?" The book was Darwin's famous work on "Earthworms," which in the course of three months reached a fifth edition. Mr. Murray gives the incident as an illustration of the extreme modesty of a very distinguished man. The same magazine contains some stories of snake cannibalism, by Mr. H. Stewart. A very readable story, in which observations of the planet Mars, and projects of signalling to our ruddy brother, are described, is contributed by Mr. J. Munro to *Cassell's Family Magazine*. Mr. Munro makes the Martians signal to us by means of lights from various incandescent elements, the natures of which are detected spectroscopically. He has a lively imagination, and is fairly accurate in his astronomical references. In the *English Illustrated*, we notice another of Mr. Grant Allen's "Moorland Idylls"—this time on butterflies; and also something about lions, by Mr. Phil Robinson. In the *Strand Magazine*, Mr. J. Holt Schooling gives a number of ingenious diagrams for graphically representing statistics relating to the population of different countries. There is also the concluding part of an article by Mr. W. G. FitzGerald, on "Some Curiosities of Modern Photography," in which, among other illustrations, occur Prof. Boys' pictures of moving bullets, and a good reproduction of Dr. Roberts' photograph of the nebula in Andromeda. Another article of interest to photographers appears in *Le Monde Moderne* for February, under the title "Les Mouvements de l'Ouvrier." A number of excellent reproductions of some of M. Marey's photographs accompany this article. The same magazine contains a description of compressed air systems of tramway traction.

In addition to the magazines mentioned in the foregoing, the following have been received, but they do not contain any articles of scientific interest:—*Contemporary*, *Century*, *Scribner*, *Chambers's*, *Longman's*, *National*, *Sunday Magazine*, and *Humanitarian*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An examination will be held at Merton College on Tuesday, July 2, 1895, and following days, beginning at 10 a.m., for the purpose of electing to three open Natural Science Scholarships, of which one will be at Merton College, one at New College, and one at Corpus Christi College.

The scholarships are of the value of £80 per annum, and are open to all candidates whose age on July 8, 1895, will not exceed nineteen years. The subjects of examination will be (1) Chemistry, Mechanics and Physics, or (2) Biology. An English essay, and a paper in Algebra and Elementary Geometry, will also be set to all candidates. Candidates will have an opportunity of showing a knowledge of higher mathematics. Candidates who offer Biology are requested to send to the Tutor in Natural Science, Merton College, at least one fortnight before the examination, a general statement as to the portions of the subject which they have studied, and the practical work which they have done. All such candidates will be required to show some acquaintance with Chemistry, Mechanics and Physics.

CAMBRIDGE.—The following is the speech delivered on February 28th by the Public Orator, Dr. Sandys, Fellow and Tutor of St. John's, in presenting for the honorary degree of Doctor in Science Sir William MacGregor, M.D. (Aberdeen), K.C.M.G., Administrator of British New Guinea :—

Orbis terrarum inter insulas, praeter Australiam latissime patet insula Australiae parti septentrionali ex adverso posita. Tota quidem insula insulis Britannicis duplo maior: insulae autem pars a Britannis occupata Anglia ipsâ maior dimidio. Nostrae vero coloniae ibi administrandae praepositus est vir insignis, olim in Academiâ Aberdoniensi medicinae doctor, nuper scientiarum complurium non modo fautor et adiutor, sed etiam ipse auctor atque investigator indefessus. Praesidis nostri auxilio, Anthropologiae, Geographiae, Geologiae, aliis denique scientiis nova lux affulsit, adeo ut coloniam illam remotissimam non tam imperii nostri propugnaculum quam scientiarum arcem et castellum longinquum appellaverim. De Caledoniae filiis, quibus ubique terrarum plurimum debet Britannia, nonnumquam dicitur, cum peregre absint, tum demum sese sentire esse domi. Huic Caledoniae filio paullisper reduci gratias hodie idcirco agimus, quod, a patriâ vocatus, non modo imperii nostri in utilitatem, sed etiam scientiae ad fructum, patriam relinquere est dignatus. Gens autem illa antiqua, ex quâ ortus esse confitetur, olim sedibus paternis expulsa et ipso nomine prorsus privata, hodie, talium virorum auxilio, non sine nomine, non sine gloriâ est. Etenim gens illa Alpina, gentem fortissimam a poetâ Romano quondam laudatam aemulata,

duris ut ilex tonsa bipennibus,
nigrae feraci frondis in Algido,
per damna, per caedes, ab ipso
ducit opes animumque ferro.

Duco ad vos equitem insignem, WILLELMUM MACGREGOR.

The Report of the Syndicate for the encouragement of advanced study and research has just been issued. It proposes that approved graduates of other universities, of not less than twenty-one years of age, should be admitted as Advanced Students, with certain special privileges. Such students are to pursue, under the supervision of committees of the special Boards of Studies, (*a*) courses of advanced study, or (*b*) courses of research. The former class may be admitted, after three terms, to a part of a Tripos examination, and if they attain therein a sufficiently high standard, their names will appear in a special list distinct from the Tripos list. After residing two years, they may be admitted to the B.A. degree, and thereafter proceed in the usual course to the M.A. and other higher degrees. Research students are, after three or more terms' residence, to present a dissertation adjudged by a Degree Committee to be "of distinction as an original contribution to learning, or as a record of original research." For this a special "Certificate of Research" is to be granted by the University. Holders of the certificate who have resided at least two years, are to be entitled to the B.A. degree, and to proceed to higher degrees in the ordinary course. Cambridge graduates may, on like terms, obtain the "Certificate of Research." The original proposal to establish new degrees (B.Litt. and B.Sc.) for the class of advanced students, has been dropped; but the possibility of proceeding to the higher degrees of the University is a new feature of importance. The Report is signed by all the twelve members of the Syndicate, including the Vice-Chancellor and eight professors, representing both the literary and the scientific departments of University study. It will come before the Senate for public discussion during the present term. The main lines of the scheme resemble those of the plan provisionally adopted at Oxford, with the important difference that Oxford has taken up the idea, discarded at Cambridge, of founding special literary and scientific degrees for post-graduate students, and does not propose that they shall be eligible for the degree of Master of Arts.

A University Lectureship in Pure Mathematics will be vacant at the end of the present term, by the resignation of Dr. Forsyth, elected Sadlerian Professor. The lecturer will hold office for five years from Midsummer, 1895. Applications are to be sent to the Vice-Chancellor before Wednesday, April 24, 1895.

An examination for diplomas in Agricultural Science will be held in Cambridge in the week beginning July 1, 1895. The names of candidates are to be sent to the Registrary by June 12.

ONE or two of the new provisions in the Revised Code for Elementary Day Schools, presented to the House of Commons last week, are worth noting here. Kindergarten methods of instruction have been recognised in infants' schools for some time, but they have usually ended in the infant school. "Object-lessons and suitable occupations" are now, however, to be counted as class subjects in the lower standards of elementary schools, so that the lessons which are so valuable in training the intelligence of the infant children will be extended. Properly carried out, these natural methods of instruction are of extreme importance in developing such powers of observation and reasoning as young children possess. Another commendable addition which Mr. Acland has introduced into the Code permits visits to be made, during school hours, to museums and art galleries; not more than twenty hours in the school year to be thus employed. Visits to the museums at South Kensington cannot but have a beneficial influence upon the minds of children, and if the guide is competent, they may be made of great value. Perhaps the new feature will lead to the establishment of science museums in towns where none at present exist. It may also assist in the reduction of the bric-a-brac element (which makes many small museums little more than variety shows), and improve the arrangement and character of the collections.

SCIENTIFIC SERIALS.

American Meteorological Journal, February.—The cause of the cyclones of the temperate latitudes, by W. H. Dines. Two theories have found considerable support: (1) the convectional theory, commonly known as Ferrel's, because he so fully explained it, and showed that cyclones were caused by the convectional ascent of a current of warm air in the central parts, the heat necessary to sustain the current being supplied, at least in part, by the latent heat set free by the condensation of aqueous vapour; (2) the theory proposed by Dr. Hann, who considers that the storms are merely eddies formed in the general easterly drift of the atmosphere in temperate latitudes, just as small whirls are formed in a river. Dr. Hann found that the temperature at high mountain stations in the Alps is higher during anticyclonic conditions than during the passage of storms. Mr. Dines thinks that the evidence is in favour of Ferrel's theory, as mathematical laws show that it is a possible one, and that the latent heat set free by the condensation of moisture will, if it take the form of kinetic energy, be sufficient to produce a most violent storm.—Recent foreign studies of thunderstorms: Russia, by R. De C. Ward. The Imperial Geographical Society of Russia instituted a special study of thunderstorms in 1871, which has been continued until the present time. This service, and others subsequently established, such as that in south-west Russia by Prof. Klossovsky, have led to some valuable results. The district of greatest thunderstorm activity is the Caucasus, then the southern central region. The predominant direction of movement is north-east, and the storms occur most frequently in June and July, the maximum frequency being in the afternoon.—The *Journal* also contains other articles of minor importance, including one on the moon and rainfall, by Prof. H. A. Hazen. The figures for Boston show a remarkable maximum at the day of new moon, and an equally remarkable minimum two days after full moon.

Journal of the Russian Chemical and Physical Society, vol. xxvi. parts 2 to 8.—Among many valuable papers inserted in these issues, the following are especially worthy of notice:—On the speed of formation of the amines, by N. Menschutkin.—On the nitration of saturated hydrocarbons by means of nitric acid, by M. Konovaloff.—On the solubility of anhydrous calcium sulphate, by A. Potilitsine.—On the isomerisation of aromatic hydrocarbons obtained by Fridel's method, by M. Konovaloff.—On the structure of terpenes and similar compounds, by G. Wagner.—On the nitration of unsaturated hydrocarbons, by means of nitric acid, by M. Konovaloff.—On the halogen compounds of nitrogen, by Th. Selivanoff.—In the physical part: On the electric resistance of bismuth to alternating currents, by A Sadovsky.—On the variation of electrostatic energy, by M. Schiller.—On the variation in length of iron wire during magnetisation, by M. Rosing.—Experiments with alternating currents of high frequency, by N. Slouginoff.

Part 2 of the *Journal* contains also, as a supplement, the first number of the Memoirs (*Vremennik*) of the Central Board of Measures and Weights, which was instituted in 1893, and is placed under Prof. Mendeléeff, who is also the editor of this publication. In this first part we find besides a preface by the editor, several papers of more than local interest, namely:—The measurements made to compare the iron *sajène* of the "Committee of the year 1833" with various units of length, accomplished in 1884, by MM. Glukhoff and Zawadski. The comparison was also made with the bronze and iron yards of Airy.—On the weight of a litre of air, a very elaborate paper by Prof. Mendeléeff, in which some remarks concerning the measurements of Leduc and Lord Rayleigh, and the corrections which should be introduced into their measurements, are especially valuable. The average value arrived at by Prof. Mendeléeff is, in grams,

$$e_0 = 0{\cdot}131844\,g \pm 0{\cdot}00010.$$

—First list of the standard measures of weight and length at the Central Board, by Th. Zawadski.—Data for the elaboration of an instruction for verifying the weights and measures in the trade establishments.—Preliminary researches into new scales for grain, as a means of determining the quality of the latter, by Th. Selivanoff.

SOCIETIES AND ACADEMIES.

LONDON

Royal Society, February 7.—"On the Application of the Kinetic Theory to Dense Gases." By S. H. Burbury, F.R.S.

February 14.—"An Instrument for Cutting, Grinding, and Polishing Section-plates and Prisms of Mineral or other Crystals accurately in the desired direction." By A. E. Tutton, Demonstrator of Chemistry at the Royal College of Science, South Kensington.

In a recent communication (*Phil. Trans.* 1894, Series A. p. 887) the author described an instrument for grinding accurately orientated section-plates and prisms of crystals of artificial preparations. The success of that instrument is so complete that another instrument has been devised and constructed, which enables equally accurately orientated plates or prisms to be prepared from the relatively harder crystals of natural minerals. The instrument is not intended to replace the one previously described, which is fully adapted for all the purposes of chemical crystallographers, and the cost of which is only two-thirds that of the one now described. It is intended especially for the use of mineralogists, but, naturally, will serve all the purposes of the smaller instrument. It is constructed upon a scale one-fifth larger than the former one as regards such parts as are fundamentally similar, to confer greater strength. The mode of supporting the outer fixed cone within which the movable axes rotate, the construction of the circle and its axis and fine adjustment, and of the gun-metal axis and its counterpoising levers designed for controlling the pressure between crystal and lap, as also of the inner steel axis from which are suspended the crystal and its centering and adjusting movements, are similar in principle to the corresponding arrangements in the smaller instrument, although many details are altered for the sake of greater rigidity. The same likewise applies to the goniometrical telescope and collimator and their mode of support. The main innovations are those of a cutting apparatus, and a larger grinding table capable of being readily furnished with any one of nine interchangeable grinding and polishing laps, suitable for use with crystals of every degree of hardness. Four metallic laps are provided, of iron, gun-metal, hard white metal, and pewter respectively, the first for rough grinding with coarse emery and brick oil or water, the second and third for fine grinding with flour emery, and the fourth for polishing with rottenstone and water. A polishing lap of hard felt, for use with putty powder and water, and a lap of boxwood, are supplied. Three glass laps, one coarsely ground, another finely ground, and the third of ordinary polished plate glass, are likewise provided for use with artificial crystals. The cutting apparatus is carried upon a horizontal arm pivoted about the back pillar of the instrument, in order to permit of its removal out of the way during grinding and polishing operations, and further supported when in use upon an adjunct of the right front pillar. It consists of a 4-inch disc of soft iron, supplied with diamond edge, and intended to be lubricated with brick oil, driven by an independent driving gear carried upon the arm. The supporting attachment to the front pillar is removable when not required, and includes a traversing apparatus for directing and controlling the cutting, and a safety back-spring to prevent the possibility of undue pressure being induced between the cutting disc and the crystal by injudiciously rapid rotation of the traversing screw. Instead of actuating the driving gear of the cutting or grinding apparatus by hand, a small electric, gas, or water motor may be employed.

"On the Ratio of the Specific Heats of some Compound Gases." By Dr. J. W. Capstick, Fellow of Trinity College, Cambridge.

The experiments described are a continuation of those of which an account is given in the *Phil. Trans.* vol. clxxxv. p. 1, Kundt's dust-figure method being used, and the ratio of the specific heats corrected for deviation of the gas from Boyle's law. The results are as follows:—

Name.	Formula.	γ
Methylene chloride.....	CH_2Cl_2	1·219
Chloroform	$CHCl_3$	1·154
Carbon tetrachloride ...	CCl_4	1·130
Ethylene chloride	$C_2H_4Cl_2$	1·137
Ethylidene chloride.....	$C_2H_4Cl_2$	1·134
Ethylene	C_2H_4	1·264
Vinyl bromide.....	C_2H_3Br	1·198
Allyl chloride	C_3H_5Cl	1·137
Allyl bromide	C_3H_5Br	1·145
Ethyl formate	$HCOOC_2H_5$	1·124
Methyl acetate.....	CH_3COOCH_3	1·137
Sulphuretted hydrogen	SH_2	1·340
Carbon dioxide	CO_2	1·308
Carbon disulphide	CS_2	1·239
Silicon tetrachloride ...	CCl_4	1·129

From these, and the results given in the former paper, it follows that

(1) Replacement of one halogen by another in a compound has no effect on γ.

(2) One H in a paraffin molecule may in some cases (*e.g.* ethane and propane) be replaced by Cl without altering γ, but a second replacement always causes a fall.

(3) Carbon and silicon can be interchanged without effect on γ.

(4) Isomeric compounds have the same γ.

(5) Using γ to calculate β, the ratio of the rates of increase of intramolecular and translational energy of the molecule on a rise of temperature, we find $\frac{\beta+1}{n}$ is constant for the paraffins and their monohalogen derivatives, whence it follows that for these the ratio of the increase of mean total energy to the increase of kinetic energy of translation of the molecule is proportional to the number of atoms in the molecule.

"On some Considerations showing that Maxwell's Theorem of the Equal Partition of Energy among the Degrees of

Freedom of Atoms is not inconsistent with the various Internal Movements exhibited by the Spectra of Gases." By Prof. G. F. Fitzgerald, F.R.S.

It has been generally held that a sufficient freedom of internal motion in an atom to explain the spectra of gases proved that the theorem as to equal partition of energy among all degrees of freedom could not hold, and various suggestions have been made as to why the *proof*, as given by Maxwell, Boltzmann, and others, fails in this case. Prof Schuster has suggested that the numerous lines need not involve the same number of degrees of freedom, as it is possible that there may be connections between them such that one or two coordinates would define a motion which when analysed into its Fourier components, as is done by a grating or prism, would produce a very complex system of lines. However, even one degree of internal freedom would interfere very seriously with the observed value of the ratio of specific heats, and the object of this note is to explain how this difficulty may be surmounted without supposing that the theorem as to equal partition of energy is untrue, for it is not by any means disproved because a certain form of proof fails in certain cases.

It has been long held that the motion of the electrons on neighbouring atoms is very much controlled by the ether between them. The wave-length of light is generally many times as great as the molecular distances, so that the ether is a practically rigid connector between neighbouring electrons. Suppose now, as a particular example, that 10^6 atoms are in this sense, and so far as the motion of electrons is concerned, within one another's control. In this case the motion of these 10^6 electrons might be defined by means of, say, three coordinates. Hence, if the atoms were spheres, there would be 3×10^6 degrees of freedom plus these three degrees defining the motions of all the electrons. Now, if the total energy be equally distributed among all these degrees of freedom, each atom will only have its share of the electromotions, and its energy of external motion will only be diminished by 3×10^{-6}th part owing to the existence of the internal motion of its electrons. I need hardly say that our methods of calorimetry are by no means sufficiently delicate to detect anything of this kind. There might be a thousand such internal degrees of freedom, and yet the ratio of specific heats would agree with observation.

There is some analogy between this suggestion and the case of a sphere moving in a liquid. The presence of the liquid, although apparently endowed with an infinite number of degrees of freedom, does not really increase the degrees of freedom at all, because its motion is entirely defined by the motion of the sphere. In a somewhat similar manner, I would suggest that the presence of the million electrons does not sensibly increase the degrees of freedom of motion of the million atoms, as all their motions may be defined in terms of the motion of a few of them. That the ether would so control the motions of electrons seems almost certain from what we know of the rapidity with which electromagnetic actions are transmitted by it, showing how completely it behaves in respect of them as a system of rigid connections.

"Note on the Disease of Cabbages and allied Plants known as 'Finger and Toe,' &c." By George Massee, Royal Gardens, Kew.

The disease known in different parts of Britain as "finger and toe," "clubbing," or "anbury," attacks turnips, rape, cabbages of all varieties, radishes, and, in fact, most cultivated plants belonging to the order *Cruciferæ*. Several common weeds are also attacked, namely, charlock (*Brassica sinapistrum*, Boiss.); garlic-mustard (*Sisymbrium alliaria*, Scop.); treacle-mustard (*Erysimum cheiranthoides*, Linn.), and shepherd's purse (*Capsella bursa pastoris*, D.C.). The last-named is reported from the United States by Halsted (New Jersey Agric. Coll. Expt. Station; *Bulletin* 98, 1893), and has not been observed to be diseased in Britain, although one of our commonest weeds. The disease is characterised by the formation of numerous nodules on the root, which becomes much distorted and soon decays, forming a slimy, fœtid mass.

Berkeley (*Gard. Chron.*, p. 500, 1856) appears to have been the first to investigate the disease from a scientific standpoint, and although he did not succeed in determining the true cause, distinctly states that microscopic examination revealed the presence of a factor previously unknown in connection with plant diseases. Furthermore, Berkeley pointed out that wood ashes were a cure for the disease, and supposed this to be due to the presence of potash salts in the ash.

Owing to the serious amount of damage caused by "finger and toe" to the cabbage crop in Russia, the Government of that country offered a reward for the discovery of the cause of the disease. Woronin ("Pringsheim's Jahrb," vol. xi. p. 548, tabs. xxix.–xxxiv., 1878) undertook the investigation, and after years of patient study published an elaborate account, proving clearly that the disease was caused by a minute organism related to the fungi, to which he gave the name *Plasmodiophora brassicæ*.

In 1859, Voelcker (*Roy. Agric. Soc. Journ.*, vol. xx. p. 101, 1859) pointed out that the disease was influenced by the amount of lime present in the soil. Where little or no lime existed, as in light and sandy soils, the disease abounded, whereas in soil containing lime the disease was absent. This opinion is corroborated by the same author at a later date (*Op. cit.*, series iii. vol. v. p. 321, 1894).

A series of experiments have been carried out during four successive years at Kew, and they demonstrate the following points:—

(1) That in addition to cultivated plants, several common weeds belonging to the order *Cruciferæ* are attacked by the *Plasmodiophora*. Hence the necessity for preventing the growth of such weeds in fields and hedge-banks.

(2) That the germs of disease are present in soil that has produced a diseased crop, and retain their vitality for at least two years.

(3) That the development of *Plasmodiophora* is favoured by the presence of acids, and checked by the presence of alkalies, agreeing in this respect with the fungi rather than with bacteria.

(4) For the purpose of sterilising infected soil, experiments prove that either a dressing of lime or a manure containing potash salts is effective, the last being most valuable, as it not only destroys the germs in the soil but also arrests the disease in seedling plants, and at the same time supplies one of the ingredients necessary for the healthy growth of turnips.

February 21.—"Iron and Steel at Welding Temperatures." By T. Wrightson.

The object of this paper was to demonstrate that the phenomenon of welding in iron is identical with that of regelation in ice.

The author recapitulated experiments made by him in 1879–80, described in the *Proceedings* of the Iron and Steel Institute for those years. These experiments were upon cast iron, and proved that this form of iron possessed the property of expanding while passing from the liquid to the plastic state during a small range of temperature, and then contracted to the solid state, and that the expansion amounted to about 6 per cent. in volume. This property of iron resembles the similar property of water in freezing, which, within a range of about 4° C., expands about 9 per cent. of its liquid volume, and then contracts as the cooling proceeds.

This property of water was investigated by Prof. James Thomson and by Lord Kelvin. The former showed that from theoretical considerations there was reason to expect that in the case of a body exhibiting the anomalous property of expanding when cooled and contracting when heated, it should be cooled instead of heated by pressure or impact. Lord Kelvin investigated the problem experimentally as affecting freezing water, and completely demonstrated the truth of his brother's reasoning.

The experiments made by the author in 1879 and 1880 suggested the view that this property of ice was connected with the property of welding in iron, but this was only hypothetical, as the experiments had been made on cast iron, which probably, on account of the presence of carbon, does not possess the property of welding. Further, it was not practicable to experiment with wrought iron in the same way as with cast iron on account of the difficulty of dealing with that substance in its liquid form. Prof. Roberts-Austen has, however, given metallurgical research a recording pyrometer, and this has enabled the author to resume the investigation at the Mint. The method adopted was the heating of bars in an electric welder, and as soon as the junction of the bars was at a welding temperature, end pressure was applied by mechanical power, and the weld effected.

Observations show that a molecular lowering of temperature took place immediately the pressure was applied to the bar when in the welding condition.

The fall in temperature varied from 57° C. to 19° C., according to the circumstances of temperature and pressure.

The experiments appears to prove that wrought iron at a welding temperature possesses the same property of cooling under pressure which was proved by Lord Kelvin to exist in freezing water, and on which demonstration the generally received theory of regelation depends.

The author distinguishes the process of melting together of metals from that of welding. Either process forms a junction, but the latter takes place at a temperature considerably below the melting point.

The well-known and useful property of welding in iron appears, therefore, to depend, as in the case of regelation in ice, upon this critical condition, which exists over a limited range of temperature between the molten and the plastic state.

"Note on the Spectrum of Argon." By H. F. Newall.

In the course of a spectroscopic investigation in which the author has been for some time past engaged, a line spectrum, which so far as he was able to make out was unknown, had frequently presented itself upon his photographs. It appeared in May and June, 1894, under conditions which led him to call it, for the sake of convenience, "the low-pressure spectrum." It now appears that the lines are argon lines.

The argon of which the spectrum was observed was obtained from air, from which nitrogen was eliminated by passing electric discharge through it in presence of hydrogen or moisture and acid. Seventy-two lines in the author's "low-pressure spectrum" had their wave-lengths given in the paper, and side by side were given the measurements of the wave-lengths determined by Mr. Crookes for the argon lines.

The agreement of the measurements shows conclusively that the same spectrum was observed. The agreement of grouping and intensity, also, leaves no doubt as to the identity of the two spectra.

The experiments were repeated, with slight variations, several times with results which, so far as the spectrum of argon is concerned, were constant. But it was noted that continued passage of the discharge appears to result in the attaining of a certain minimum pressure, after which there is slight and slow rise to a tolerably-fixed pressure.

It is interesting to find argon asserting itself, unsolicited, in quite new circumstances, and under conditions which practically constitute one more mode of separating argon from nitrogen—namely, the getting rid of nitrogen by passing electric discharge through it in the presence of hydrogen or moisture and acid.

February 28.—"The Effect of Environment on the Development of Echinoderm Larvæ: an Experimental Inquiry into the Causes of Variation." By H. M. Vernon (from the Zoological Station, Naples).

The conditions of environment under which an organism develops are known to be of considerable influence in the production of variations. It was thought to be of interest to determine by exact measurement the effects which such slight changes in the environmental conditions as might occur naturally would produce in the growth of some organisms. The animal chosen was the larva or pluteus of the sea-urchin *Strongylocentrotus lividus*. These larvæ develop readily from artificial fertilisations, and they can, moreover, be obtained at all times of the year, irrespective of season. In all 10,000 larvæ were measured.

The effects of temperature on development were first studied. It was found that if the ova were placed in water at about 8° or 25° C. for an hour, or even for a minute, at the time of impregnation, the resulting larvæ after eight days development were, on an average, 4·6 per cent. smaller than those impregnated at from 17° to 22°, though all the subsequent conditions of development were identical. If kept at the abnormal temperature for only ten seconds during impregnation, the resulting larvæ were only 1·7 per cent. smaller.

The time of the year when the artificial fertilisations are prepared has a very marked influence on the size of the larvæ. Thus, those obtained in the middle of August are about 20 per cent. smaller than those obtained in April, May, and October, whilst those obtained in June and July are intermediate in size.

The salinity of the water has also a great influence on the development.

The effects which the various colours of the spectrum have upon the development were also determined, though these are not conditions of environment which occur in nature. The development of the larvæ seems to be but little affected if it is carried out in absolute darkness, the size only being diminished by 1·3 per cent. Larvæ grown in semi darkness are apparently 2·5 per cent. larger than the normal.

The body-length of the larvæ appears to be uninfluenced by the number of larvæ developing together in a given volume of water, if it be kept below 30,000 per litre. The arm-lengths are, on the other hand, considerably affected.

Certain products of metabolism exert a favourable influence on the developments of the larvæ, and not, as would be naturally expected, a harmful one.

As the number of measurements made was so large, it was thought to be of interest to subject them to statistical examination. It was found that with the body-length and oral arm-length measurements the deviations from the average occurred with a frequency indicated by the theoretical law of error. The measurements of the aboral arm-length did not agree so well, possibly owing to dimorphism.

Physical Society, February 22.—Captain Abney, F.R.S., President, in the chair.—An abstract of Mr. G. H. Bryan's paper, on the mechanical analogue of thermal equilibrium between bodies in contact, was read by Mr. Elder. After commenting on the difficulty in applying the kinetic theory of gases to the case of two substances in contact which do not mix, the author goes on to describe a system by which the phenomena of thermal equilibrium unaccompanied by diffusion can be explained. The two substances are represented by two sets of molecules designated by P and Q. Two parallel planes A and B, at a small distance apart, are imagined to divide space in three parts. Plane A (to the left of B) is supposed to be permeable to the P molecules, but to repel the Q molecules, whilst B is permeable to the Q set of molecules, and repels the P set. The spaces to the left of A and to the right of B are thus entirely occupied by the P and Q molecules respectively. Between the planes both P and Q molecules exist, and therefore have opportunities of colliding with one another and transferring energy from one gas to the other. Using generalised coordinates, it is shown by Boltzmann's method that when equilibrium is attained the mean kinetic energies of translation of the two kinds of molecules are equal, just as in the case of molecules which mix. Instead of assuming the planes A and B to repel the Q and P molecules respectively, the P molecules may be assumed to be positively electrified, and the Q ones negatively electrified, whilst the planes A and B are maintained at a constant difference of potential. The difference of potential thus assumed is analogous to "contact E.M.F." whose existence is proved by experiment. The communication concludes with a development of Prof. Boltzmann's paper on the application of the determinantal relation to the kinetic theory of polyatomic gases, read before the British Association at Oxford. Dr. Stoney thought the arguments were based on actions depending on the distances of the molecules, and the supposition that they were rigid. In his opinion events occur in nature which are not represented by this simple theory, and great reservation should be shown in accepting dynamical problems which leave out of account actions occurring between matter and the ether. In nature nothing was large and nothing was small except relatively. Even molecules might possess infinite detail of structure. Their interaction with the ether must be considered in any complete theory.—Mr. G. U. Yule's paper on a new harmonic analyser, and one by Mr. H. N. Allen, on the electromagnetic field, were postponed.

Chemical Society, February 21.—Dr. Armstrong, President, in the chair.—The following papers were read:—The electromotive force of an iodine cell, by A. P. Laurie. The E.M.F. of a cell consisting of a zinc and platinum plate immersed in iodine dissolved in potassium iodide solution is constant, but is the smaller as the iodine solution is the more dilute; the effect of varying the constituents of the cell on the E.M.F. has been investigated.—Contributions to the chemistry of cellulose, by C. F. Cross, E. J. Bevan, and C. Beadle. The melting-points of mixtures, by H. Crompton and Miss M. A. Whiteley. When a solution deposits the pure solvent on cooling, the relation $\log s = \frac{\rho}{1{\cdot}98} \cdot \frac{T - T^1}{T\,T^1}$ holds; s is the number of molecules of solvent per molecule of solution, ρ is the molecular latent heat of fusion of the solvent, and T and T^1 the melting-points of the solvent and the solution respectively.—The volumetric determination of manganese, by J. Reddrop and H.

Ramage. Schneider's process for the determination of manganese may be rendered much more accurate by substituting sodium bismuthate for bismuth peroxide.—Bromocamphoric acid, an oxidation product of π-dibromocamphor, by F. S. Kipping. A bromocamphoric acid is obtained by oxidising π-dibromocamphor; its anhydride has been prepared together with a new hydroxy-acid and a nitrobromocamphor.—Note on the action of diastase on cold starch-paste, by H. T. Brown and G. H. Morris.—On the magnetic rotation of some unsaturated hydrocarbons, by W. H. Perkin. The magnetic rotations of a number of unsaturated open-chain hydrocarbons have been determined; a comparison of hexane, hexylene, diallyl, and dipropargyl shows that the differences between the latter pair are of a different order to those of the former pair.

Linnean Society, February 7.—Mr. C. B. Clarke, F.R.S., President, in the chair.—Mr. Thomas Christy exhibited a dried specimen of *Aplopappus Llaretæ* and samples of the so-called Gum Kino, *Pterocarpus erinaceus*, of which some account was given by Mr. E. M. Holmes. Mr. George Murray exhibited a number of lantern slides of floating *Algæ*, of which he gave brief descriptions referring to the localities in which they had been found and the literature relating to them.—By permission of the Director of the Royal Gardens, Kew, Mr. W. B. Hemsley exhibited dried specimens of a number of new plants from Eastern Asia. Conspicuous amongst these was a new genus of *Scitamineæ* from the mountains of Northern Siam, characterised by having minute unisexual flowers destitute of staminodia, a one-celled ovary with parietal placentation, and two filiform stylodia; a remarkably broad-leaved *Lysimachia* from the same region; new species of *Hypericum*, *Ventilago*, *Mesona*, and *Helicia* from Formosa; and a new genus of *Cyrtandreæ*. From a collection made in Yunan, Western China, by Mr. W. Hancock, of Hong Kong, came a new *Jasminum*, allied to *J. nudiflorum*, with primrose yellow flowers an inch and a half in diameter; an elegant species of *Petrocosmea* (Cyrtandreæ), and a showy *Brandisia* (Scrophularineæ) with long racemes of crimson flowers, which were much admired.—Mr. Thomas Hanbury exhibited a beautiful collection of fresh fruits of the *Aurantieæ* grown in his own garden at La Mortola, Mentone, and gave an account of some of the more remarkable varieties, their mode of growth, and the conditions under which they had been grown.—A paper was then read by Mr. H. M. Bernard, on the comparative morphology of the *Galeodidæ*. Having described a possible origin for the Crustacea from a chætopod annelid by an adaptation of the anterior segments to a method of feeding, whereby the parapodia would function as jaws, the author attempted the same for the Arachnida with a view to solve the question of their relationship with the Merostomata. The *Galeodidæ* were chosen for special study because, unlike other arachnids, they have retained some segments of the cephalothorax as free movable segments, and hence might be expected to throw light on the subject. The author believed that he had solved the question of the primitive specialisation of the arachnid phylum from their annelidan ancestors, and expressed the opinion that as arthropods they are not related either to the Crustacea (including *Limulus*) nor to the Hexapoda; but that all these are distinct derivations of the Annelida. In an interesting discussion which followed, the paper was criticised at some length by Mr. A. D. Michael, Prof. Howes, and Mr. R. I. Pocock.

PARIS.

Academy of Sciences, February 25.—M. Lœwy in the chair.—On the penetration of a projectile in semi-fluids and solids, by M. H. Resal.—On a class of equations of which the general integral is uniform, by M. Emile Picard.—On the measurement of time in astronomy by a method independent of personal equation, by M. G. Lippmann. The author employs a photographic method. A platinum wire is rendered incandescent for a very short time at the commencement of each second by mechanical means. The light from the wire is, by the aid of arrangements described, thrown on to a photographic plate in such a way that the image formed corresponds precisely with the meridian of the place of observation. By suitable exposure a photograph is obtained of a portion of the heavens on the same plate. The time of transit of a given star can then be easily deduced from the horary circles photographed as above. M. d'Abbadie remarked with reference to an alternative micrometric method proposed by M. Lippmann, that Breguet had used a moving wire grating for measurement of the same quantities fifty years previously.—On the mutual relations of potential determinants, by M. de Jonquières.—Ebullioscopic study of certain colouring matters from triphenylmethane, by MM. A. Haller and P. Th. Muller. The conclusion is drawn that, under the given experimental conditions, the hydrochlorides of the colouring substances of the triphenylmethane amido group are not dissociated, whereas the chlorides of ammonium bases and nitrosodimethylaniline hydrochloride are most clearly dissociated. Hence an argument may be drawn in favour of formulæ of the type of $ClC : (C_6H_4.NH_2)_3$ due to M. Rosenstiehl.—M. Sappey gave a short description of the "Atlas of Descriptive Anatomy," presented by M. Laskowski.—The Academy elected M. Weierstrass as foreign associate, the votes given being: M. Weierstrass 43, Prof. Frankland 1, Prof. Huxley 1.—A closed communication from M. E. Carvallo, accepted May 2, 1892, was opened. It gave the theory of the laws of crystalline absorption. For uniaxial crystals these are: (1) For the ordinary ray, the index of refraction and the coefficient of absorption are constant, whatever may be the angle between the luminous ray and the crystallographic axis. (2) The law of the index of the extraordinary ray is not altered sensibly by absorption. (3) The absorption of the extraordinary ray is represented by the formula

$$\frac{k}{n^3} = \frac{k_o}{n_o{}^3}\cos^2\Theta + \frac{k_e}{n_e{}^3}\sin^2\Theta,$$

where k, n, Θ represent the coefficient of absorption, the index of refraction, and the angle between the normal to the plane of the wave and the crystallographic axis. A memoir will shortly be brought out dealing with these results and their developments.—M. L. L. de Koninck claims priority for the properties of nickel and cobalt sulphides.—Spectrum researches on the rotation and movements of the planets, by M. H. Deslandres. (See "Our Astronomical Column.")—Observations on the subject of the preceding communication by M. Deslandres, by M. H. Poincaré. The theoretical views which have been confirmed by the foregoing results.—Determination of the position of the pole by photography, by M. C. Flammarion. By exposure of a fixed plate, circular traces of the circumpolar stars are obtained as shown in the figure given with the paper. Hence the position of the pole can be obtained with great accuracy.—On a surface of the sixth order which is connected with Kummer's surface, by M. G. Humbert.—On functional equations, by M. Lean.—On the exact invariants of an ordinary differential equation of the second order, by M. Tresse.—On some theorems of Arithmology, by M. N. Bougaief.—Lowering of the freezing point and relative diminution of vapour pressure in dilute solutions, by M. A. Ponsot. The author deduces formulæ differing somewhat from those given by Wüllner and Raoult, and agreeing with those of van t'Hoff and Duhem, with the exception that a different meaning is given to one of the terms.—On the lowering of the freezing point of very dilute solutions, by M. A. Leduc. The author proposes the substitution of the measurement of a considerable pressure for a small temperature difference. A theoretical demonstration.—On a sensitive pressometer, for the measurement of fluid pressures, by M. Paul Charpentier.—The measurement of the intensity of light by the chemical action produced; experiments with mixtures of ferric chloride and oxalic acid, by M. Georges Lemoine.—On some combinations of lead iodide with other metallic or organic iodides, by M. A. Mosnier. A number of new double salts have been obtained and their composition determined.—On some combinations of nitric oxide with the chlorides of iron, by M. V. Thomas. The substances: (1) $Fe_2Cl_6.NO$, (2) $2Fe_2Cl_6.NO$, (3) $FeCl_2.NO.2H_2O$, and (4) $FeCl_2.NO$, have been obtained and their composition determined by analysis.—Action of formaldehyde on hydroxylamine hydrochloride and on methylamine hydrochloride, by MM. A. Brochet and R. Cambier.—Active amyl ethereal salts, by MM. Ph. A. Guye and L. Chavanne. A paper on the product of asymmetry.—New researches on the correlative variations of the intensity of thermogenesis and respiratory changes, by M. Laulanié.—"*Autonarcose carbonico-acétonémique*," or winter sleep of the marmot, by M. Raphael Dubois.—On the *Rhinatrema bivittatum*, Cuvier, by M. Léon Vaillant.—Evolution of the nervous system and of the vibratile organ in the larvæ of compound ascidians, by M. Antoine Pizon.—On the rôle of Amæbocytes in the Annelids, by Emile G. Racovitza. Amæbocytes serve not only to deposit

the excretory pigment in the epidermis, but when necessary, take up and digest for the benefit of the organism all the accumulated reserve substances.—Natural and artificial protophylline, by M. C. Timiriazeff.—On some applications of Oceanography to Geology, by M. J. Thoulet.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MARCH 7.

ROYAL SOCIETY, at 4.30.—The Rubies of Burma and Associated Minerals: their Mode of Occurrence, Origin, and Metamorphoses. A Contribution to the History of Corundum: C. Barrington Brown and Prof. Judd, F.R.S.—The Action of Heat upon Ethylene, Part II. Prof. V. B. Lewes.—On the Measurement of Pressures by the Crusher-Gauge: W. Kellner and W. H. Deering.

SOCIETY OF ANTIQUARIES, at 8.30.

LINNEAN SOCIETY, at 8.—On the Genus Cupressus: Dr. Maxwell T. Masters, F.R.S.—On the Insects, Arachnida, and Crustacea collected during Mr. T. Bent's Expedition to Hadramant, Arabia: W. F. Kirby, Chas. Gahan, and R. I. Pocock.

CHEMICAL SOCIETY, at 8.—Dimethylketohexamethylene: Dr. Kipping.—The Use of Barium Thiosulphate in Standardising Iodine: Dr. Plimpton and T. C. Chorley.—The Magnetic Rotation of the Plane of Polarisation of Light by Liquids: J. W. Rodger and W. Watson.—Irimethylsuccinic Acid: Prof. W. H. Perkin, F.R.S., and Dr. W. Bone.

FRIDAY, MARCH 8.

ROYAL INSTITUTION, at 9.—The Physical Work of Von Helmholtz: Prof. A. W. Rücker, F.R.S.

PHYSICAL SOCIETY, at 5.—Exhibition, by Mr. Naber, of a Voltameter.—(1) The Focal Heliostat; (2) An Improvement in Siderostats: Dr. G. Johnstone Stoney, F.R.S.—On a New Harmonic Analyser: G. U. Yule.—On the Electromagnetic Field: H. N. Allen.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Micrometrical Measures of the Diameter of the Satellites of Jupiter; Micrometrical Measures of the Ball and Ring System of Saturn, and of the Diameter of Titan: E. E. Barnard.—Transit of Mercury, 1894 November 10: W. F. Gale; J. P. Thomson.—A List of Probably New Double Stars: R. T. A. Innes.—Double Star Measures: W. H. Maw and J. Tebbutt.—Notes on the Variable Stars X and W Sagittæ: Lieut.-Colonel Markwick.—Note on a Suggested Form of Equatorial Mounting for a Modified Newtonian Reflector: Rev. C. D. P. Davies.—On the Proper Motions of B.A.C. 793 and Cephei 24 (Hev.): W. T. Lynn.—The Wilsonian Theory and the Stonyhurst Drawings of Sun-spots: Rev. W. Sidgreaves.—Observations of Encke's Comet: Royal Observatory, Greenwich.—An Apparatus for Mechanically Calculating Star Corrections: W. E. Cooke.—Note on the above Paper: Prof. H. H. Turner.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Coordinate System of Surveying as employed in South Africa: A. Struben.

MALACOLOGICAL SOCIETY, at 8.

CLINICAL SOCIETY, at 8.30.

SATURDAY, MARCH 9.

ROYAL INSTITUTION, at 3.—Waves and Vibrations: Lord Rayleigh, F.R.S.

ROYAL BOTANIC SOCIETY, at 3.45.

ESSEX FIELD CLUB (at Stratford), at 6.30.—Notes on the Remains of Pleistocene Mammals found in the Neighbourhood of Chelmsford: E. T. Newton, F.R.S.—Note on the Section at Chelmsford in which the Mammoth and other Remains were discovered, November 1894: T. V. Holmes.

SUNDAY, MARCH 10.

SUNDAY LECTURE SOCIETY, at 4.—Perpetual Motion: Douglas Carnegie.

MONDAY, MARCH 11.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Three Years' Travelling and Fighting in the Congo Free State: Captain S. L. Hinde.

AFFILIATED PHOTOGRAPHIC SOCIETIES (Cordwainers' Hall, E.C.), at 8.—The Physics and Chemistry of Development: Thomas Bolas.

MEDICAL SOCIETY, at 8.30.

TUESDAY, MARCH 12.

ROYAL INSTITUTION, at 3.—Internal Framework of Plants and Animals: Prof C. Stewart.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Kidderpur Docks, Calcutta: William Duff Bruce.—Note on the Movement of the Walls of the Kidderpur Docks: James Henry Apjohn.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Changes in the Proportions of the Human Body during the Period of Growth: Dr. Wingfield Hall.—Notes on the Language spoken in Madagascar: J. T. Last.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—An Unconsidered Property of Photographic Lenses: T. R. Dallmeyer.

ROYAL VICTORIA HALL (Waterloo Bridge Road), at 8.—Photographic Astronomy: Mr. Knobel.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY, at 8.30.

ROYAL HORTICULTURAL SOCIETY, at 1.—The Diseases of Tomatoes and Vines.

WEDNESDAY, MARCH 13.

PHARMACEUTICAL SOCIETY, at 8.30.

SOCIETY OF ARTS, at 8.—The Meat Supply of the United Kingdom: E. Montague Nelson.

THURSDAY, MARCH 14.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ANTIQUARIES, at 8.30.

MATHEMATICAL SOCIETY, at 8.—The Invariants of the Binary Quantic of Unlimited Order: The President.—Certain π Functions: F. H. Jackson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electrolysis of Gold: N. S. Keith.

FRIDAY, MARCH 15.

ROYAL INSTITUTION, at 9.—The Rarer Metals and their Alloys: Prof. Roberts-Austen, C.B., F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.—The Value of Eucalyptus Oil as a Disinfectant in Scarlet Fever: Dr Joseph Priestley.

QUEKETT MICROSCOPIC CLUB, at 8.

SATURDAY, MARCH 16.

ROYAL INSTITUTION, at 3.—Waves and Vibrations: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Elements of Pathological Histology: Dr. A. Weichselbaum, translated by Dr. W. R. Dawson (Longmans).—Le Léman: F. A. Forel, tome second (Lausanne, Rouge).—Everybody's Pocket Lawyer (Saxon).—A Treatise on Elementary Trigonometry: Dr. J. Casey, new edition (Dublin, Hodges).—Appareils Accessoires des Chaudières a Vapeur: Dudebout and Cromeau (Paris, Gauthier-Villars).—Traité des Bicycles et Bicycletes: C. Bourlet (Paris, Gauthier-Villars).—Conic Sections: Dr. W. H. Besant, 9th edition (Bell).—Organic Chemistry—the Fatty Compounds: R. L. Whiteley (Longmans).—Smithsonian Geographical Tables: R. S. Woodward (Washington).—Les Aurores Polaires: A. Angot (Paris, Alcan).—My Weather-wise Companion: B. T. (Blackwood).—The Fauna of British India, including Ceylon and Burma—Moths: G. F. Hampson, Vol. 3 (Taylor and Francis).

PAMPHLETS.—Index to the Literature of Didymium, 1842–1893 (Washington).—Report of S. P. Langley, Secretary of the Smithsonian Institution, for the Year ending June 30, 1894 (Washington).—Report on the Operations of the Department of Land Records and Agriculture, Madras Presidency, for the Official Year 1893–94 (Madras).—Zwei Neue Paradiesvögel: A. B. Meyer (Berlin, Friedländer).

SERIALS.—Natural Science, March (Nait).—Cassell's Magazine, March (Cassell).—Contemporary Review, March (Isbister).—Humanitarian, March (Hutchinson).—Bulletin de la Académie Royale des Sciences, &c., de Belgique, 65e Année 3e série, tome 29. No. 1 (Bruxelles).—Zeitschrift für Physikalische Chemie, xvi. Band, 2 Heft (Leipzig, Engelmann).—Scribner's Magazine, March (Low).—Zeitschrift für Naturwissenschaften, 66 Band, 5 and 6 Heft, 67 Band, 1 to 5 Heft (Leipzig, Pfeffer).—National Review, March (Arnold).

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