THURSDAY, FEBRUARY 2, 1893.

TROPICAL AGRICULTURE.

A Text-book of Tropical Agriculture. By H. A. Alford Nicholls, M.D., F.L.S., C.M.Z.S., with illustrations, pp. 312. (London: Macmillan and Co., 1892.)

THIS text-book is the English edition of a work that has already received high commendation from the Government of Jamaica. The Government of this now prosperous colony, in pursuance of a policy (which may well be followed by other colonies) offered a premium of one hundred pounds for the best text-book of Tropical Agriculture adapted for the use of colleges and higher schools in the colony. The award was made to Dr. Nicholls's manuscript, and after the publication of the work in Jamaica it was adopted also as a text-book by the Government of other colonies, so that its value has been practically estimated beforehand. The author's qualifications for the task he has undertaken may be gathered from the following:—

"Twelve years ago, when he had to direct his attention to tropical agriculture, there was no practical book that he could turn to for help in all the difficulties that were constantly cropping up in his path. Knowing, therefore, the obstacles that usually beset the inexperienced planter who is not content to follow the old grooves of unscientific agriculture, the author has so written the second part of this book as to afford the information he needed greatly in his own planting novitiate. This has rendered it necessary to enter into details, which to the experienced agriculturist may appear superfluous, but the book is really intended as a guide to the young and unlearned to whom such details are likely to be of essential service."

As an introduction to tropical agriculture this book supplies a want long felt. There are several works of a technical character treating of old and well-established industries such as sugar, tea, coffee, cacao. None of these, however, could be adopted as text-books in schools. Indeed they all presuppose such a close acquaintance with the principles and terminology of tropical agriculture that they appeal to a very limited class of readers. Hitherto, tropical agriculture, to a large extent, has borrowed most of its methods from the agriculture of temperate climates and adapt them, as well as it could, to the very different circumstances of the torrid zone. The result has been by no means satisfactory. In tropical regions effects follow cause so rapidly that methods admirably adapted to the cold, sluggish climates of northern countries are most injurious when too closely followed in the tropics. As instances we may cite the serious effects on climate following the extensive cutting down of forests, and the wholesale washing away of surface soil from land under permanent cultivation by the destructive influences of tropical rains. The merit of Dr. Nicholls's book lies in the fact that its precepts are directly based on his own experience, and he appeals so effectively to the intelligence of his readers that they cannot fail to be instructed. The work is divided into two parts:—Part I. deals with the elementary principles of agricultural science and discusses amongst other subjects the origin and composition of soils, the nature of plant life, the controlling influence of climate, the action and constituents of manures, the rotation of crops, the drainage of soils, irrigation, tillage operations, pruning, budding, and grafting. In Part II. there is treated the application of these principles to some of the chief of the various cultivations undertaken in tropical countries. As examples we may mention that there are detailed accounts given of the methods found most successful in the cultivation of coffee, cacao, tea, sugar-cane, fruits, spices, tobacco, drugs, dyes, tropical cereals, and such food plants as cassava, arrowroot, yams, sweet potato, tania (*Colocasia*).

The book is intended also, according to the preface, to be of service to peasant proprietors, owners of small estates, and to those [European] settlers who from time to time may wish to make their homes in the tropics. It is just these people who are now building up the new prosperity of the West Indies by means of what are called "minor industries" or *la petite culture*—which the French have found so remunerative in many of their colonies. To guide and instruct the mass of small cultivators in the West Indies has been the dream of the most enlightened Governors, such as Sir John Peter Grant, Sir Anthony Musgrave, Sir William Robinson, and others that have ruled there for the last thirty years. The intelligent settlers of European origin can very well take care of themselves: but the mass of the small cultivators are black people. They have, it is true, received some education, and they are not wanting in intelligence in regard to what concerns their own interests, but their methods of cultivation have, hitherto, been of the rudest and most destructive description. They crop the land year after year without any manuring, and when it is thoroughly exhausted they move on, when they can, to fresh land, and treat that in exactly the same way. Thus in the black man's system of cultivation the rotation is of land, and not of crops, and the future has to take care of itself. This is a relic of the times of slavery, when the negroes were allowed as much land as they cared for—out of reach of sugar cultivation—to grow provisions for their own subsistence. It is now necessary to change the whole character of the black man's cultural methods, or the rich and fertile lands still left in the West Indies will be absolutely ruined. Generally only the lowest class of negroes have hitherto been attracted to field work. The education given to these people is responsible for something of this result, for it leads them, in too many cases, to regard labour in the field as degrading, and almost a return to a state of slavery. The sharper and more intelligent boys, when they leave school, are drawn away to seek a precarious existence as clerks in stores or as small shopkeepers, where they seldom do more than copy the weaknesses and vices of the whites, while, according to our author, if they took to the land, and had a right understanding of agricultural methods, they "need never despair of becoming prosperous." In the more advanced colonies, such as Jamaica, there is a disposition to establish industrial schools and train the younger generation in approved methods of cultivation, and lead them to regard the tillage of the soil as a more honourable and remunerative occupation than petty trading. We may hope that the claims of industrial education will become more widely recognized, not only in the West Indies but in all our tropical colonies where native races have to be dealt

with. In the meantime colleges and schools must prepare competent instructors for the work, and for both teacher and taught this book is an admirable starting-point. In it the whole field of small industries is well covered, and the language is clearly expressed and well chosen. As an example of the author's treatment we find under manures (p. 49):—

"The land must be regarded by the planter as a bank in which he has opened an account. If he continually draw cheques on the bank, and make no fresh deposit to meet the drain, he will sooner or later come to the end of his capital, and the same argument applies to the soil. In cacao and coffee cultivation in the West Indies, particularly on lands of peasant proprietors, one often sees the planter take away crops year after year, whilst he does next to nothing to make up for the heavy drain on the land; and then, after a time he finds he gets very small crops, and he thinks the fault lies with the trees, or that the soil is not adapted to the cultivation, whereas the fault is entirely his own, as he has gone on taking away from the soil without putting anything back." Again, "the great fault hitherto committed by tropical planters has been the confining of their attention to one kind of cultivation on their land. If several different crops were taken off alternately, as in a system of rotation, or grown in different parts of the land, where the soil and climate prove suitable, the planter would be in a much better position than he is now, for he would not 'have all his eggs in one basket.'"

It is noticed that the valuable services rendered to colonial industries by Kew and by the various botanical institutions in correspondence with Kew are fully recognised. Further, the dedication of this first Text-book of Tropical Agriculture to Sir Joseph Hooker is a compliment not only to his own distinguished services, but also to those of his father, for both in their day took the deepest interest in the West Indies. It must be gratifying to the late Director of Kew to learn "in the quiet of his retirement that the influence of his work lives on and bears fruit even in the far-away field" of the West Indies.

D. M.

CELLS: THEIR STRUCTURE AND FUNCTIONS.

Die Zelle und Die Gewebe, Grundzüge der allgemeinen Anatomie und Physiologie. Von Prof. Dr. Oscar Hertwig. (Jena: Gustav Fischer, 1892.)

TEXT-BOOKS on Histology introduce the structure of the tissues to their readers by a chapter on cells, and the best treatises on Anatomy, either human or comparative, usually devote some pages to the consideration of these, the most elementary of all the tissues. As so many important advances have been made of late years in our knowledge of the structure of cells and their contained nuclei, of the properties of protoplasm, of the division of nuclei and the part played by the nucleus in cell multiplication, and of the influence exercised by cells in the problems of hereditary transmission, the time has obviously arrived for the production of a treatise devoted to the description of the cell in its various aspects, observational as well as speculative. No better expositor of the subject in all its bearings could be found than Prof. Oscar Hertwig, who has himself conducted important investigations on this branch of anatomy. The book now before us treats of the general anatomy and physiology of cells, and is to be followed by a second volume, in which the origin and physiological properties of the tissues are to be expounded, as well as their structure.

After a sketch of the history of the cell theory and of the theory of protoplasm, in which, as is too often the case in German text-books, the names of British observers and authors are conspicuous by their absence, he defines a cell to be a little clump of protoplasm which incloses a specially-formed constituent, the nucleus; a definition which accords with those previously made by Leydig and Max Schultze. He then describes at considerable length the characters of protoplasm, both anatomical and physiological, and the chemico-physical and morphological properties of the nucleus. In a short section he discusses the question, Do elementary organisms exist without nuclei? *i.e.* Can you have little clumps of non-nucleated protoplasm pursuing an independent life? As is well known, Haeckel described organisms of this simple character, as cytodes, and gave Monera as an example; but Hertwig is disposed to think that such non-nucleated organisms have not been definitely demonstrated in the animal kingdom, and he quotes Bütschli's observations, which seem to show that even in such micro-organisms as Bacteria a differentiation of a nucleus from surrounding protoplasm can be distinguished.

Two important chapters are written on the movements of protoplasm, of cilia, of flagella, of spermatozoa, on contractile vesicles, and on the irritability of protoplasm under the stimulus of heat, light, electricity and several kinds of mechanical and chemical irritants. The fifth chapter is devoted to the consideration of the nutritive changes and formative activity in cells. Illustrations are given of the power possessed by certain unicellular organisms of taking into their substance and digesting solid bodies of various kinds, and an account is appended of the important observations of Metschnikoff on phagocytosis.

Chapters six and seven are occupied with a description of the multiplication of cells, their mode of division, and the method of fertilization. The process of karyokinesis is described at some length and in its various phases, in clear and precise language, and with an amount of illustration which enables the reader to follow without difficulty this complicated process. The influence exercised by the nucleus, and the part which it plays in the process of cell multiplication, has now been put by the labours of many investigators on a basis of observation, both as regards plants and animals, such as cannot be controverted, and the accuracy of the generalization made half a century ago, both by Martin Barry and John Goodsir, that young cells originate through division of the nucleus of a parent cell, has been amply established.

Dr. Hertwig also recites observations which seem to show that the nucleus does more than act as a reproductive centre within the cell, but also takes a part in cell nutrition. This function of the nucleus was also contended for by Goodsir, but during the period when protoplasm was regarded as the essential element in nutrition or secretion, the claim of the nucleus to take any share in this phase of cell activity was summarily put aside. Recent observations have, however, shown that

clumps of protoplasm, removed from either a unicellular plant or animal, in which no nucleus is present, although capable of living, and retaining their irritability and power of movement for some time, yet neither grow, nor form a cell membrane, nor have the same power of digesting bodies introduced into their substance, as is possessed by a clump of protoplasm which has retained the nucleus. The nutritive activity of the protoplasm would appear, therefore, to be under the influence of the nucleus.

The volume concludes with a chapter on the cell in its relation to theories of heredity. The author, as is now the prevailing opinion amongst biologists, contends that the nucleus is the conveyer of hereditary properties, and that the offspring is a mixed product of both its parents, derived from the ovum and the sperm cell. In the course of this chapter he discusses the views of Darwin, Spencer, Nägeli, Weismann, and De Vries, and suggests the employment of the term "Idioblasts" for the minute elementary particles, which Darwin called "gemmules" in his hypothesis of pangenesis, and which he conceived to be capable of transmitting hereditary characters to succeeding generations.

THEORETICAL MECHANICS.

Elementary Mechanics of Solids and Fluids. By A. L. Selby, M.A. (Oxford: Clarendon Press, 1893.)

AT a period when we are bound to recognize the influence exerted by the examinations of the various educational institutions and of those controlled by other more or less influential examining bodies, we may be excused, on the arrival of a new work, for stating whether or not, and to what extent, it is adapted to their requirements. The book before us does not appear to have been intentionally written for examination purposes, and perhaps on this account it will be all the more welcome. Its purpose, however, is very distinct. It is intended for those students who are desirous of reading mechanics as an introduction to a study of physics. So far, therefore, as its suitability for examinations is concerned, we can heartily recommend it to those who wish to qualify in this particular branch of science, while at the same time it will be read with great benefit by that class of students who desire a thorough knowledge of the portions generally included under the head of Theoretical Mechanics.

In the study of such subjects as the book treats of, the amount of knowledge which the reader may have of mathematics will, to a considerable extent, be a measure of his success. The author expresses a hope that an acquaintance with the elements of algebra and geometry will suffice; but, while not wishing to reduce the usefulness of the book, but rather to direct it into proper hands in which it will be read with greater advantage, we think it would be nearer the mark to say that a thorough knowledge of elementary algebra and a considerable acquaintance with elementary trigonometry are necessary. Certainly the definitions of the trigonometrical ratios will be found in an appendix, but it will be far better if the student has lived with and used these for some time.

Possessing these requirements, he will appreciate and even admire the broad, yet concise nature of the treatment generally; and with regard to this matter we may say that we are unacquainted with any elementary text-book better calculated to create a desire for precise and full ideas. That this is requisite for a study of physics perhaps more than any other subject, no one will deny.

The first chapter of the book is occupied with a consideration of Kinematics, and in it will be found a careful exposition of the displacement, velocity, and acceleration to which a body may be subjected, due attention being drawn to what is necessary for a full representation of them. The appendix following this contains some geometrical theorems and definitions for subsequent use. Then follow the usual chapters on the laws of motion, work, and energy, centre of gravity, moments of inertia, and simple machines. A chapter on gravitation will be read with interest, preceded as it is by an explanation of some of the geometrical properties of the ellipse. Kepler's laws of planetary motion are dealt with, in addition to other relevant matters which do not usually find their way into elementary text-books.

The subject of elasticity also receives a somewhat more extensive treatment than is usually given to it. The various kinds of stress and strain which a body may undergo are explained, together with the relation between stress and strain. At the end of the book we find what is included under the second head of the title. The various principles and laws which refer to fluids, and some of the machines and instruments which depend on them for their action, are enumerated and explained, while the interesting subject of capillarity has a separate chapter devoted to it.

To an appreciative reader it is a source of satisfaction to observe the care the author has exercised when dealing with the important matter of definitions and units—fundamental and derived. A chapter on units and their dimensions is furnished at the end.

A good selection of examples, bearing on the matter treated therein, will be found at the close of the chapters.

Many portions of the book are characterized by a decided freshness of treatment, and we have little doubt that the careful reader will find many little points which are satisfying, in that they tend to widen the somewhat restricted views he may have previously held, and these will be all the more apparent should his mind be of a mathematical turn. G. A. B.

OUR BOOK SHELF.

Magnetism and Electricity. By R. W. Stewart. (London: W. B. Clive and Co.)

THE book forms one of the University Correspondence College Tutorial Series, and is "primarily written for the use of candidates for the Matriculation, Intermediate Science, and Preliminary Scientific Examinations of the University of London." The author is evidently familiar with the difficulties which usually occur to students, and the best portions of the book are those in which efforts are made to elucidate some of the more general errors. The descriptions of apparatus and phenomena are, however, generally rather short and meagre, while the diagrams are frequently inadequate for a work of this sort. Little is written to help the beginner to perform experiments for himself; in fact, descriptions of many important instruments are omitted—for example, the Wheatstone

Bridge—and to students having no access to a laboratory little satisfaction will be given when told: "The details of the construction and practical use of the different forms of Wheatstone's Bridge used in the measurement of resistance are best learnt in the laboratory, and for this reason we shall not give any further description of the arrangement."

In many instances the student is driven through a mass of theory before he has a fair idea of the general phenomena; thus in the introductory chapter on "Current Electricity," after a six-line description of a simple cell and current, over two pages are occupied in proving that the effects produced could be explained by the dissociation and procession of the hydrogen and oxygen atoms. The work is generally remarkably free from errors and misprints, but one occurs in the explanation just mentioned. The attraction of zinc for oxygen is said to be much greater than that of the copper, while later the zinc is also considered "to *repel* hydrogen *less*." Here, and in many other instances, the words to be emphasised are printed in italics. Another mistake will be found on pp. 168 and 169, where in comparing, by the method of oscillations, the field due to a magnet with that of the earth, the author starts with the equation $\frac{I+H}{I}=\frac{n_1^2}{n^2}$ instead of $\frac{I+H}{H}=\frac{n_1^2}{n^2}$, and reasoning correctly from this false hypothesis, he deduces false results, while the answer to Ex. 8 on this part of the subject appears incorrect. Fig. 13, p. 201, in illustration of Oerstedt's experiment, is not correctly drawn.

The arrangement of "calculations" and examples at the end of each chapter must prove extremely useful to students possessing beforehand an elementary knowledge of the general phenomena, and to such, rather than to the very beginner, the book may be commended. H. S. J.

Manners and Monuments of Prehistoric Peoples. By the Marquis de Nadaillac. Translated by Nancy Bell (N. D'Anvers). (New York and London: G. P. Putnam's Sons, 1892.)

A BOOK summing up in a popular style all that is now known with regard to prehistoric man would probably be welcomed by a tolerably large class of readers. The present work does not quite supply the kind of summary that is wanted. The author does not distinguish with sufficient clearness between the various periods with which he deals; he indulges too freely in talk of a vaguely moralising tendency; and some of his statements do not accord with the conclusions of the best authorities. Speaking of the Round Towers of Ireland, for instance, he says, "According to the point of view of different archæologists, they have been called temples of the sun, hermitages, phallic monuments, or signal towers." The reader is thus left to suppose that the question is still open, whereas all competent students of the subject accept the theory of the late Mr. Petrie, a theory which the Marquis de Nadaillac does not even mention. However, the author has presented a large number of interesting facts in the course of his exposition, and there are occasional passages in which he brings out very well the attractive elements of some of the more fascinating departments of archæology.

LETTERS TO THE EDITOR.

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

Two Statements.

IN a letter addressed to the *Daily Chronicle*, dated January 25, 1893, Prof. Karl Pearson makes two statements respecting my opinions and grounds of action:

"As in society at large, so in academic matters, his mode of insuring progress is unlimited individual competition,"

and again:

"he is an individualist in all matters."

Seeing that in an essay "On Administrative Nihilism," published twenty-two years ago; and in another on "Government: Anarchy or Regimentation," published in 1890, I have done my best to combat the doctrine Prof. Pearson attributes to me, I shall be glad to know what justification he has to offer for so grave a misrepresentation. The purpose of it is obvious.

T. H. HUXLEY.

Hodeslea, Eastbourne, January 29.

A Meteor.

THE following is taken from the Pretoria *Weekly Press* for January 7: "A few evenings ago a meteor of unusual size and brilliancy was observed at Bloemfontein shooting right across the eastern sky. It looked like a rocket of a greenish colour, and burst in a shower of sparks in the south-east. The spectacle was much admired by those who were fortunate enough to witness it."

This meteor, as seen in South Africa, appears to have had many points in common with a similar one seen in England about the same time, and reported by several observers in the daily Press.

W. L. DISTANT.

Purley, Surrey, January 31.

"Hare-lip" in Earthworms.

ATTENTION has recently been drawn by Prof. Andrews (*American Naturalist*, September, 1892) and myself (*Science Gossip*, 1892) to some abnormal conditions of life among the terrestrial annelids. I have now to place on record a totally new appearance, which is, I think, very aptly expressed by the term "hare-lip." The worm which I have had under examination presented the peculiarity figured below, and when alive and in motion suggested to my mind most forcibly the appearance which we associate with the name I have adopted.

The specimen in question belongs to the genus Allolobophora, in which genus, so far as my experience goes, almost all the abnormalities are found. The genus Lumbricus, it should be observed, is very seldom, if ever, known to present any of these peculiarities. Hitherto the Long worm (*A. longa*, Ude)

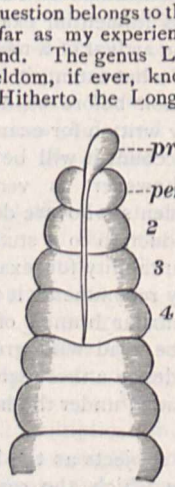

Diagram of the anterior portion of green-worm (*Allolobophora chlorotica*. Savigny), showing abnormal appearance of lip (*pr*), peristomium (*per*), and three succeeding segments, seen from above, and enlarged.

has been most prolific of bifurcated heads and tails. Now we find the Green worm (*A. chlorotica*, Savigny) yielding new features for study. The peculiarities which have presented themselves in former times have usually taken the form of a second head or a supernumerary tail. In this instance there is no off-growth, however, but merely a malformation of the anterior segments. One might have supposed that the peculiarity was due to accidental causes. It would have been easy to suppose that the head had been split, and then the wound had healed, leaving a seam down the middle. I observed, however, that each of the three specimens of the Green worm which I received from Cork (Ireland) showed some abnormal feature, and there were other peculiarities in this particular specimen which indicated that we had to deal with a congenital rather than an accidental condition of things.

As this is the first occasion on which such a peculiarity has been recorded or figured, I prefer to leave all speculation as to the cause out of the question. We need a good deal more research before we can deal satisfactorily with the biological problems involved in such appearances. As a help towards this, I bring together here a list of all those works which have come under my own and Prof. Andrews's notice, in which abnormalities in annelids are recorded :—

1. Andrews: "Proc. U.S. Nat. Mus.," vol. xiv., p. 283, 1891.
2. Andrews: "Amer. Nat.," vol. xxvi., p. 725, 1892.
3. Bell: "Ann. Mag. Nat. Hist.," vol. xvi., p. 475, 1885.
4. Bell: "Proc. Zool. Soc., Lond.," 1887, p. 3.
5. Bonnet: "Œuvres d'Hist. Nat. et de Phil.," vol. i., p. 167 seq. 1779.
6. Breese: West Kent Nat. Hist. Soc., 1871.
7. Broome: "Trans. Nat. Hist. Soc." Glasgow, 1888, p. 203.
8. Bülow: "Archiv. f. Naturg," vol. xlix., 1883.
9. Brunette: "Travaux de la Sta. Zool. de Cette," p. 8, Nancy, 1888.
10. Claparède: "Les Chaet. du Golfe de Naples," p. 436, 1868.
11. Fitch: "Eighth Report on Insects of State of New York," appendix, p. 204 seq. Albany, 1865.
12. Foster: Hull Scientific Club, February, 1891. Reported in weekly sup. *Leeds Mercury*.
13. Friend: "Science Gossip," 1892, pp. 108, 161.
14. Grube: "Archiv. f. Naturg.," vol. x., p. 200, 1844.
15. Horst: "Tydsch. ned. Dierk. Veren," 2nd ser., D.I., Af. i., p. xxxii, 1882.
16. Laugerhaus: "Nov. Act., K.L.C.D. Acad.," vol. xiii., p. 102, 1879.
17. Marsh: "Amer. Nat.," vol. xxiv., p. 373, 1890.
18. Macintosh: "*Challenger* Reports," vol. xii., 1885.
19. Robertson: "Quart. J. Mic. Soc.," vol. xv., p. 157, 1867.
20. Zeppelin: "Zeit. f. Wiss. Zool.," vol. xxxix., p. 615 seq. 1883.
21. Catalogue Terat. Spec. in Mus. Roy. Coll. Surgeons, London, 1872.

HILDERIC FRIEND.

The Zero Point of Dr. Joule's Thermometer.

IN the course of a discussion on "Exact Thermometry" I described (NATURE, vol. xli. p. 488) the results obtained by heating thermometers for a considerable time to 280° and 356°; and pointed out by means of a diagram that at 356°, after about ten hours, the rise of the zero point became—at any rate approximately—a rectilinear function of the logarithm of the time; though at 280°, even after more than 300 hours' heating, the rise appeared to be rather more rapid than would correspond to such a simple relation.

Dr. Joule observed the rise of the zero point of a thermometer at the ordinary temperature during a course of no less than thirty-eight years ("Scientific Papers," vol. i. p. 558), and it occurred to me that it would be of interest to ascertain the relation to the logarithm of the time in this case also.

The following table contains the dates of Dr. Joule's observations; the total number of months from the date when the first reading was taken; the corresponding logarithms; the total rise of the zero point in scale divisions (13 divisions to 1° F.); the total rise calculated from the formula $R = 6{\cdot}5 \log. t - 4{\cdot}12$, where t is the time in months; and lastly the differences between the observed and calculated zero points.

Date.	Time in Months.	Log. t.	Total rise of zero point in scale divisions. Observed.	Calculated.	Δ
April 1844	0	—	0	—	—
Feb. 1846	22	1·342	5·5	4·6	−0·9
Jan. 1848	45	1·653	6·6	6·6	0
April 1848	48	1·681	6·9	6·8	−0·1
Feb. 1853	106	2·025	8·8	9·0	+0·2
April 1856	144	2·158	9·5	9·9	+0·4
Dec. 1860	200	2·301	11·1	10·8	−0·3
March 1867	275	2·439	11·8	11·7	−0·1
Feb. 1870	310	2·491	12·1	12·1	0
Feb. 1873	346	2·539	12·5	12·4	−0·1
Jan. 1877	393	2·594	12·71	12·74	+0·03
Nov. 1879	427	2·630	12·92	12·98	+0·06
Dec. 1882	464	2·667	13·26	13·22	−0·04

The agreement between the observed and calculated values is certainly remarkable, and the + and − differences are evenly distributed.

Ten years have now elapsed since the last reading was taken, and if the thermometer is still in existence it would be of great interest to know what further rise has taken place in its zero point. According to the equation the reading should now be 13·86.

SYDNEY YOUNG

University College, Bristol, January 20.

THE APPROACHING SOLAR ECLIPSE, APRIL 15–16, 1893.

THE total solar eclipse of April 15–16, 1893, is not only one of the longest of the century, but is the last of the century from which we are likely to get any addition to our knowledge of Solar Physics. The longest duration of totality of this eclipse is 4 minutes 46 seconds, and as the path of the moon's shadow lies to a great extent on land, there is a considerable choice of possible stations with long durations of totality. Commencing in the Southern Pacific the line of totality passes in a north-easterly direction and enters Chili at Charañah in 29° southern latitude, crosses the South American continent, and issues at Para Cura, a village near Ceara, at the north-east corner of Brazil, in latitude 3° 40′ south. It crosses the Atlantic at its narrowest part and enters Africa at Point Palmerin, near Joal, almost midway between Bathurst and Dakar, and in latitude 14° north; the shadow finally leaving the earth in the interior of Northern Africa. The eclipse will be observed by several parties of astronomers in Chili, Brazil, and Africa, there being almost absolute certainty of fine weather in Chili and Africa, and a reasonable probability in Brazil.

The English arrangements to observe the eclipse have been made by a joint committee of the Royal Society, the Royal Astronomical Society, and the Solar Physics Committee of the Science and Art Department, South Kensington; Dr. A. A. Common, LL.D., F.R.S., undertaking the duties of Secretary. Two expeditions will be sent from England, one to Africa and the other to Brazil, the expenses being defrayed by a grant of £600 from the Royal Society.

The African expedition will be in charge of Prof. T. E. Thorpe, and will consist of Prof. Thorpe, Mr. A. Fowler, Mr. Gray, and Sergeant J. Kearney, R.E. The Brazilian expedition will be in charge of Mr. A. Taylor, who will have with him Mr. W. Shackleton.

Prof. Thorpe and his party will leave Liverpool by the British and African mail steamer on March 18th, arriving at Bathurst on April 2nd. They will be met at Bathurst by a gunboat kindly placed at the disposal of the expedition by the Admiralty, and will be conveyed at once to Fundium, a station on the Salum River, about sixty miles from Bathurst; this being the station selected by the Committee from the three which were offered by the French Government. The gunboat will remain with the expedition, and the officers and crew will assist in the preparations for and in the actual observations of the eclipse. After the eclipse the party will be taken to Bathurst on the gunboat, and will return to England by a British and African mail steamer, if one is available. From the time-tables of the steamers now published it appears, however, that there will not be any mail steamer available until the end of April, and in this case a cruiser will meet the party at Bathurst and bring them to the Canary Islands or to Gibraltar, from either of which places they will be able to return by mail steamer, arriving in England early in May.

The members of the expedition to Brazil will leave Southampton by the Royal Mail steamer on February 23 for Pernambuco, arriving at the latter place on March 12. They will take passage by the local mail steamers to Ceara, at which place they will arrive about March 20.

The Brazilian Government are willing to place a war vessel at the disposal of the foreign expeditions to observe the eclipse, and it is hoped the English observers will be able to avail themselves of the privilege thus gracefully offered. The station selected is at Para Cura, on the coast about forty miles west of Ceara, and the party will rely upon obtaining any necessary help from the Brazilian authorities and from local assistants. The observers will return from Pernambuco by the Royal Mail steamer due to leave there on April 22, and expect to be in England on May 5.

The objects of the expeditions are—

(1) To obtain visual photometric measures of the light of the corona.

(2) To obtain photographs of the corona with the four-inch lenses of a little over sixty inches focus belonging to Captain Abney, which were successfully used in Egypt (1882), Caroline Island (1883), Granada (1836), and Salut Isles (1889), in order to continue the series.

(3) To obtain enlarged photographs of the corona with small photographic action, so as to show details of the structure of the brightest parts, *i.e.* those nearest the sun.

(4) To measure the photographic intensity of the light of the corona, by direct comparison with standard intensity scales placed on the margins of the plates used for the negatives to be obtained under sections 2 and 3.

(5) To obtain photographs of the spectrum of the corona. These spectra will be obtained on three different plans:—

(*a*) With integrating spectroscopes, where no collimator is used and the prism or prisms are placed directly in front of the object glass of the photographic camera.

(*b*) With ordinary slit spectroscopes, the slit being arranged as a radius of the sun.

(*c*) With ordinary slit spectroscopes, the slit being arranged as a tangent to the sun's limb.

The first of these objects will be attempted only at the African station; Prof. Thorpe and his assistant, Mr. Gray, making the observations. Their equipment will consist of a six-inch Simms equatorial of seventy-eight inches focus (lent from Greenwich) fitted with special photometric apparatus lent by Captain Abney. The observations will be made on essentially the same plan as that pursued by Prof. Thorpe at Hog Island, near Granada, in 1886, separate portions of the corona being compared with a standard glow lamp by means of a Bunsen photometer. An integrating box for measuring the total coronal light with as little light from the sky as possible, and an ordinary Bunsen's bar photometer will also be used, these being entrusted to officers of the gunboat.

As regards objects 2, 3, and 4, duplicate apparatus has been arranged for use at the two stations.

A photoheliograph mounting from Greenwich has been lent for Brazil, and an exactly similar instrument from South Kensington for Africa. On each of these mountings a specially designed new double tube will be fixed. An Abney lens will be mounted in one compartment of each of these tubes, and this, with a focal length of sixty inches, will give pictures on the scale of rather more than half an inch to the moon's diameter. In the other compartment a four-inch Dallmeyer photoheliograph lens will be mounted in combination with a specially-constructed two-and-a-half-inch Dallmeyer negative lens of eight inches negative focus; this arrangement giving, with a total length of sixty-eight inches, pictures on the scale of over one-and-a-half inches to the moon's diameter. This latter arrangement is essentially the same as that of Dallmeyer's new telephotographic lens. It will be so arranged that the ratio between the photographic effect of the Abney lens and the new combination will be as 10 : 1.

Special plate holders have been made to fit the double tubes, each of these plate holders carrying two plates, which will be exposed simultaneously to the images formed by the Abney lens and the enlarging combination. The six separate exposures, giving twelve photographs, will be so arranged that the longest exposed pictures with the enlarging combination will have received the same photographic action as the shortest exposed pictures with the Abney lens. The whole of the pictures will thus form a continuous series, all the short exposures in the series having a direct enlargement of three diameters.

In Brazil Mr. Taylor will take charge of this double instrument, and in Africa the similar instrument will be entrusted to Sergeant Kearney. On the night before the eclipse intensity scales for object 4 will be impressed by the use of standard lights and specially-constructed scales kindly supplied by Captain Abney on all the plates to be exposed to the corona. The plates will be developed at the stations as soon as convenient after the eclipse, experience on previous occasions, both by English and American observers, having shown that it is impossible to repack undeveloped plates after exposure in the tropics, and bring them home without serious deterioration.

Similar spectroscopic work is to be carried out at the two stations. For the integrating spectroscope in Africa Mr. Fowler will use a six-inch objective prism with a six-inch photographic lens of about nine-feet focus, mounted on an equatorial stand, belonging to Prof. J. Norman Lockyer, and kindly lent for the expedition. At the Brazilian station Mr. Shackleton will use two three-inch prisms in front of a three-inch photographic lens of about two-feet focus; the spectroscope, which belongs to South Kensington, being arranged horizontally and used with a ten-inch heliostat, also lent by the Science and Art Department. Very short exposures will be given at each station at the commencement and end of totality, so as to obtain, if possible, the very numerous bright lines which have been observed in the chromosphere; and exposures of from 5 to 45 seconds will be given during totality.

In Africa the radial and tangential slit spectroscopes will be mounted together on the Corbett equatorial stand lent from Greenwich, the spectroscopes used belonging to the Royal Society. Mr. Fowler and Sergeant Kearney will erect and adjust these instruments, but the actual exposure, which will extend through the whole of totality, will be made by an officer of the gunboat who will be placed in charge of the instrument. In Brazil the radial and tangential slit spectroscopes will be mounted horizontally and used with a second ten-inch heliostat lent by the Science and Art Department. The erection and adjustment will be made by the observers, but the actual exposure during totality will be entrusted to a local assistant. Orthochromatic plates will be used for all the spectroscopic work, the spectra obtained extending from above D into the ultra-violet.

Briefly summarised, the English programme is as follows:—

In Africa:—Prof. T. E. Thorpe, assisted by Mr. Gray and local assistance—Photometric measures of the visual intensity of the corona with the equatorial photometer, the integrating photometer, and the bar photometer; Mr. Fowler—The six-inch integrating spectroscope; Sergeant Kearney—the Abney and Dallmeyer coronographs; local assistance—the radial and tangential slit spectroscopes.

In Brazil:—Mr. Taylor, the Abney and Dallmeyer coronographs; Mr. Shackleton, the three-inch two-prism integrating spectroscope; local assistance, the radial and tangential slit spectroscopes.

It is not yet decided whether one of the 20-inch mirrors of 45-inches focus specially constructed to photograph the faint extensions of the corona during the eclipse of 1889 (December 21–22) will be taken to Africa. If so it will be entrusted to a local assistant. It was originally intended to use one of these in Africa, and it was hoped that one would be used by the Harvard College

Observatory party, which is to occupy a station in Chili, but Prof. W. H. Pickering writes that difficulties of transport will prevent him from taking the 20-inch mirror he has at Arequipa to the Harvard station; and owing to this and to the already large programme of the English party in Africa there is some doubt whether they will take one of the mirrors. April being the middle of the rainy season in Brazil, it is not deemed advisable to send one of the mirrors to that station.

The duration of totality at Para Cura is four minutes forty-four seconds, the altitude of the sun being between 70° and 80°. At Fundium the totality lasts four minutes eight seconds, the altitude of the sun being about 54°.

The Joint Eclipse Committee having arranged the expeditions and the general scheme of work, final details as to the actual operations have been left to a sub-committee consisting of the Astronomer Royal, Captain Abney, Mr. H. H. Turner, Prof. Thorpe, Mr. A. Taylor, and the secretary, Dr. Common. Prof. Lockyer, previous to leaving England for Egypt, determined the exposures to be given by Messrs. Fowler and Shackleton with the integrating spectroscopes. These, with the final instructions to observers drafted by the sub-committee, will be published in due course.

At present very few details are available as to the actual work to be undertaken by foreign observers. The Harvard College Observatory expedition to Chili has already been mentioned. Prof. Schaeberle, of the Lick Observatory, has already started for Chili, and will use a six-and-a-half-inch equatorial, a five-inch horizontal photoheliograph of forty-feet focus, and a Dallmeyer portrait lens. He will be assisted by Mr. Gale, an amateur, from Paddington, N.S.W. A Chilian party will also observe the eclipse in Chili.

At Para Cura there will probably be two or three American parties, one being announced as probably under Prof. H. S. Pritchett, from Washington University, St. Louis, and another will probably be brought to that station by Prof. David P. Todd. A Brazilian party will also observe. The Bureau des Longitudes, Paris, are sending a complete expedition to Joal, in Africa, under MM. Deslandres and Bigourdan, the latter observer having already started for his station. The work undertaken will be to obtain photographs of the corona and of its spectrum. M. de la Baume Pluvinel will also go to Joal to photograph the corona. At present we have not heard of any Italian expedition, but it is hoped that Prof. Tacchini will be able to arrange to observe the eclipse.

A. TAYLOR.

MEASURE OF THE IMAGINATION.[1]

THE first perceptible sensation is seldom due to a solitary stimulus. Internal causes of stimulation are in continual activity, whose effects are usually too faint to be perceived by themselves, but they may combine with minute external stimuli, and so produce a sensation which neither of them could have done singly. I desire now to draw attention to another concurring cause which has hitherto been unduly overlooked, or only partially allowed for under the titles of expectation and attention. I mean the Imagination, believing that it should be frankly recognised as a frequent factor in the production of a just perceptible sensation. Let us reflect for a moment on the frequency with which the imagination produces effects that actually overpass the threshold of consciousness, and give rise to what is indistinguishable from, and mistaken for a real sensation. Every one has observed instances of it in his own person and in those of others. Illustrations are almost needless; I may, however, mention one as a reminder; it was current in my boyhood, and the incident probably took place not many yards from where I now stand. Sir Humphrey Davy had recently discovered the metal potassium, and showed specimens of it to the greedy gaze of a philosophical friend as it lay immersed in a dish of alcohol to shield it from the air, explaining its chemical claim to be considered a metal. All the known metals at that time were of such high specific gravity that weight was commonly considered to be a peculiar characteristic of metals; potassium, however, is lighter than water. The philosopher not being aware of this, but convinced as to its metallic nature by the reasoning of Sir Humphrey, fished a piece out of the alcohol, and, weighing it a while between his finger and thumb, said seriously, as in further confirmation, "How heavy it is!"

In childhood the imagination is peculiarly vivid and notoriously leads to mistakes, but the discipline of after life is steadily directed to checking its vagaries and to establishing a clear distinction between fancy and fact. Nevertheless, the force of the imagination may endure with extraordinary power and be cherished by persons of poetic temperament, on which point the experiences of our two latest Poet-Laureats, Wordsworth and Tennyson, is extremely instructive. Wordsworth's famous "Ode to Immortality" contains three lines which long puzzled his readers. They occur after his grand description of the glorious imagery of childhood, and the "perpetual benediction" of its memories, when he suddenly breaks off into—

> "Not for these I raise
> The song of thanks and praise,
> But for those obstinate questionings
> Of sense and outward things,
> Fallings, from us, vanishings," &c.

Why, it was asked, should any sane person be "obstinately" disposed to question the testimony of his senses, and be peculiarly thankful that he had the power to do so? What was meant by the "fallings off and vanishings," for which he raises his "song of thanks and praise"? The explanation is now to be found in a note by Wordsworth himself, prefixed to the ode in Knight's edition. Wordsworth there writes—"I was often unable to think of external things as having external existence, and I communed with all I saw as something not apart from, but inherent in, my own immaterial nature. Many times while going to school have I grasped at a wall or tree to recal myself from this abyss of idealism to the reality. At that time I was afraid of such processes. In later times I have deplored, as we all have reason to do, a subjugation of an opposite character, and have rejoiced over the remembrances, as is expressed in the lines 'Obstinate questionings,' &c." He then gives those I have just quoted.

It is a remarkable coincidence that a closely similar idea is found in the verses of the successor of Wordsworth, namely, the great poet whose recent loss is mourned by all English-speaking nations, and that a closely similar explanation exists with respect to them. For in Lord Tennyson's "Holy Grail" the aged Sir Percivale, then a monk, recounts to a brother monk the following words of King Arthur:—

> "Let visions of the night or of the day
> Come, as they will; and many a time they come
> Until this earth he walks on seems not earth,
> This light that strikes his eyeball is not light,
> The air that smites his forehead is not air,
> But vision," &c.

Sir Percivale concludes just as Wordsworth's admirers formerly had done: "I knew not all he meant."

Now, in the *Nineteenth Century* of the present month

[1] Extract from a lecture on "The Just-Perceptible Difference," delivered before the Royal Institution, on Friday, January 27, by Francis Galton, F.R.S. We hope to give next week an extract on "Optical Continuity."

[1] Knight's edition of Wordsworth, vol. iv. p. 47.

Mr. Knowles, in his article entitled "Aspects of Tennyson," mentions a conversational incident curiously parallel to Wordsworth's own remarks about himself:—"He [Tennyson] said to me one day, 'Sometimes as I sit alone in this great room I get carried away, out of sense and body, and rapt into mere existence, till the accidental touch or movement of one of my own fingers is like a great shock and blow, and brings the body back with a terrible start."

Considering how often the imagination is sufficiently intense to stimulate a real sensation, a vastly greater number of cases must exist in which it excites the physiological centres in too feeble a degree for their response to reach to the level of consciousness. So that if the imagination has been anyhow set into motion, it shall as a rule originate what may be termed *incomplete* sensations, and whenever one of these concurs with a real sensation of the same kind, it would swell its volume.

This supposition admits of being submitted to experiment by comparing the amount of stimulus required to produce a just perceptible sensation, under the two conditions of the imagination being either excited or passive.

Several conditions have to be observed in designing suitable experiments. The imagined sensation and the real sensation must be of the same quality; an expected scream and an actual groan could not reinforce one another. Again, the place where the image is localised in the theatre of the imagination must be the same as it is in the real sensation. This condition requires to be more carefully attended to in respect to the visual imagination than to that of the other senses, because the theatre of the visual imagination is described by most persons, though not by all, as internal, whereas the theatre of actual vision is external. The important part played by points of reference in visual illusions is to be explained by the aid they afford in compelling the imaginary figures to externalise themselves, superimposing them on fragments of a reality. The visualisation and the actual vision fuse together in some parts, and supplement each other elsewhere.

The theatre of audition is by no means so purely external as that of sight. Certain persuasive tones of voice sink deeply, as it were, into the mind, and even simulate our own original sentiments. The power of localising external sounds, which is almost absent in those who are deaf with one ear, is very imperfect generally, otherwise the illusions of the ventriloquist would be impossible. There was an account in the newspapers a few weeks ago of an Austrian lady of rank who purchased a parrot at a high price, as being able to repeat the Paternoster in seven different languages. She took the bird home, but it was mute. At last it was discovered that the apparent performances of the parrot had been due to the ventriloquism of the dealer. An analogous trick upon the sight could not be performed by a conjuror. Thus he could never make his audience believe that the floor of the room was the ceiling.

As regards the other senses the theatre of the imagination coincides fairly well with that of the sensations. It is so with taste and smell, also with touch, in so far that an imagined impression or pain is always located in some particular part of the body, then if it be localised in the same place as a real pain, it must coalesce with it.

Finally, it is of high importance to success in experiments on Imagination that the object and its associated imagery should be so habitually connected that a critical attitude of the mind shall not easily separate them. Suppose an apparatus arranged to associate the waxing and waning of a light with the rising and falling of a sound, holding means in reserve for privately modifying the illumination at the will of the experimenter, in order that the waxing and waning may be lessened, abolished, or even reversed. It is quite possible that a person who had no idea of the purport of the experiment might be deceived, and be led by his imagination to declare that the light still waxed and waned in unison with the sound after its ups and downs had been reduced to zero. But if the subject of the experiment suspected its object he would be thrown into a critical mood; his mind would stiffen itself, as it were, and he will be difficult to deceive.

Having made these preliminary remarks, I will mention one only of some experiments I have made and am making from time to time, to measure the force of my own imagination. It happens that although most persons train themselves from childhood upwards to distinguish imagination from fact, there is at least one instance in which we do the exact reverse, namely, in respect to the auditory presentation of the words that are perused by the eye. It would be otherwise impossible to realise the sonorous flow of the passages, whether in prose or poetry, that are read only with the eyes. We all of us value and cultivate this form of auditory imagination, and it commonly grows into a well-developed faculty. I infer that when we are listening to the words of a reader while our eyes are simultaneously perusing a copy of the book from which he is reading, that the effects of the auditory imagination concur with the actual sound, and produce a stronger impression than the latter alone would be able to make.

I have very frequently experimented on myself with success, with the view of analysing this concurrent impression into its constituents, being aided thereto by two helpful conditions, the one is a degree of deafness which prevents me when sitting on a seat in the middle rows from following memoirs that are read in tones suitable to the audience at large; and the other is the accident of belonging to societies in which unrevised copies of the memoirs, that are about to be read, and usually in monotones, are obtainable, in order to be perused simultaneously by the eye. Now it sometimes happens that portions of these papers, however valuable they may be in themselves, do not interest me, in which case it has been a never-flagging source of diversion to compare my capabilities of following the reader when I am using my eyes, and when I am not. The result depends somewhat on the quality of the voice; if it is a familiar tone I can imagine what is coming much more accurately than otherwise. It depends much on the phraseology, familiar words being vividly re-presented. Something also depends on the mood at the time, for imagination is powerfully affected by all forms of emotion. The result is that I frequently find myself in a position in which I hear every word distinctly so long as they accord with those I am perusing, but whenever a word is changed, although the change is perceived, the new word is not recognised. Then, should I raise my eyes from the copy, nothing whatever of the reading can be understood, the overtones by which words are distinguished being too faint to be heard. As a rule, I estimate that I have to approach the reader by about a quarter of the previous distance, before I can distinguish his words by the ear alone. Accepting this rough estimate for the purposes of present calculation, it follows that the potency of my hearing alone is to that of my hearing *plus* imagination, as the loudness of the same overtones heard at 3 and at 4 units of distance respectively; that is as about 3^2 to 4^2, or as 9 to 16. Consequently the potency of my auditory imagination is to that of a just perceptible sound as 16–9, or as 7 units, to 16. So the effect of the imagination in this case reaches nearly half-way to the level of consciousness. If it were a little more than twice as strong it would be able by itself to produce an effect indistinguishable from a real sound.

Two copies of the same newspaper afford easily accessible materials for making this experiment, a few words having been altered here and there in the copy to be read from.

I will conclude this portion of my remarks by suggesting that some of my audience should repeat these experiments on themselves. If they do so, I should be grateful if they would communicate to me their results.

PROTOCERAS, THE NEW ARTIODACTYLE.

LAST year the American Museum of Natural History established a department of mammalian palæontology for the purpose of securing and exhibiting collections from all the tertiary horizons of the west. Dr. J. L. Wortman, well known by his discoveries while associated with Prof. Cope, was put at the head of the field work, and under his direction explorations have already been made in the Laramie or Upper Cretaceous, and in three of the great divisions of the tertiary, namely, the Wasatch, the Puerco, and the Lower Miocene or White River.

The discovery of the first example of *Palæonictis* found in America was mentioned in NATURE last year. From the Puerco are brought remains of about 400 individuals, adding many new facts to the discoveries of Prof. Cope. From the Laramie are 400 of the small isolated teeth of the kind recently described by Prof. Marsh. These are found by the writer to have a distinctly tertiary rather than mesozoic character, and while intermediate between the mesozoic and Puerco species, they decidedly resemble the latter. *Meniscoëssus*, for example, about which there has been so much discussion, proves to be a plagiaulacid,

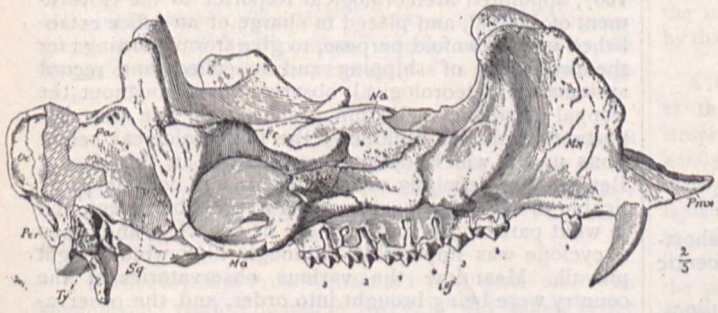

FIG. 1.—Side view of skull.

and also an ancestor of *Polymastodon*, which is thus shown to be a huge *Plagiaulax*, in which the fourth cutting premolar is reduced.

By far the most perfect specimens have, however, been brought from the Lower Miocene; and here it appears that practically a new horizon has been developed, for the collection is full of fresh forms. Many of these are new species intermediate between the true White River or *Titanotherium* fauna, and the Middle Miocene, but others are new genera, and represent distinct unrelated forms.

In this Lower Miocene collection are included portions of six skulls and the fore and hind feet of an Artiodactyle, of about the size of a sheep. The most complete skull is here figured exactly as found, and is seen at once to depart from all known Artiodactyles in many important characters. There are no less than four protuberances upon each side of the skull. Hindmost are two processes upon the parietals, which are placed upon the superciliary ridges as they diverge from the sagittal crest. These processes are close together and oval in section, reminding us of the posterior pair of horns in *Uintatherium* rather than of the conical or rounded horns found in the giraffes and some other Artiodactyles. Their position upon the parietal bones is also peculiar. The superciliary ridges extend outwards into two widely projecting plates of bone, which curve upwards above the orbits; these plates are upon the frontals, and the frontals also bear a pair of small conical processes just behind their junction with the nasals. But even more exceptional than these parietal and frontal processes are the great vertical plates rising from the maxillaries, slightly recurved, and reaching the full height of the parietal protuberances. Seen from above, these plates are found to be not in contact, but to enclose a long deep cleft, representing the anterior narial opening. This is bridged over posteriorly by the nasals, which, as shown in the second figure, are extremely abbreviated. Correlated with the development of these processes are a number of strong ridges, which form supporting buttresses for the horns. These extend, as above described, from the sagittal crest outwards, also from the anterior margin of the orbit forwards. This lateral maxillary ridge, as it may be called, terminates in a process just above the infraorbital foramen; and this process, although small, seems to illustrate the remarkable tendency of this little skull to develop osseous projections at every avail-

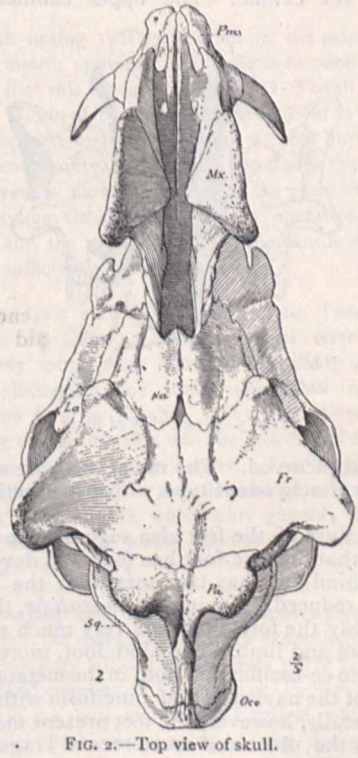

FIG. 2.—Top view of skull.

able point. The character of these projections is different from that found elsewhere among the Artiodactyla; they are not horn-cores, neither are they similar to the processes upon the parietals of the giraffe. The development of these multiple bony protuberances suggests the skulls of Sivatherium, Tetraceros, and other eastern ruminants; but the proportions of the skull are wholly different. The olfactory chamber, which is usually so expanded in the Artiodactyla, is here extremely reduced; the nasals barely reach beyond the middle line of the skull.

Up to this point the study of the skull appeared to present an entirely new form, but later the other skulls were removed from the matrix, and among them one was found with small canine teeth, entirely lacking all the processes upon the frontals, and giving indications that those upon the maxillaries were either absent or comparatively small. The parietals were unfortunately missing, but the idea at once suggested itself that this might be a female skull. Two years ago Prof.

Marsh described a small Artiodactyle with a pair of small conical horn-cores upon the parietal bones, which he named *Protoceras celer*, expressing the opinion that it represented a new family. Upon the supposition that this type might also be a female of the same species to which the heavily-horned type belonged, the second skull was taken to the Yale Museum, and carefully compared point by point. It proved to be identical in every respect. In this way the discovery was made that in *Protoceras*, as in so many other Artiodactyles, the male and female skulls differed widely from each other in their cranial armature. The male was as described above; the female exhibits merely a pair of very small conical processes upon the parietals, with perfectly smooth frontals, and maxillaries either of the normal type or with smaller protuberances than in the male.

The dentition at first suggests relationship to *Tragulus* and *Hyomoschus*. The premaxillaries are edentulous as in the ruminants; but in the lower jaw there are four small teeth shaped liked incisors, the outermost of which represents the canine. The upper canines are large,

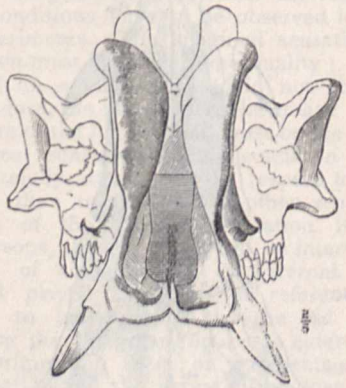

FIG. 3.—Front view of Skull.

pointed, and recurved. The molar teeth are of the short-crowned, or brachyodont type, with a distinctly crescentic pattern.

The structure of the feet also suggests the Tragulines, in the fact that the fore-foot has four well developed toes, while the hind-foot has two toes with the lateral pair very much reduced. As in the *Tragulidæ*, the fore-foot and probably the fore limb was very much shorter than the hind foot and limb. The hind foot, moreover, shows a tendency to co-ossification both in the metatarsals and in the union of the navicular and cuneiform with the cuboid. In many details, however, the feet present marked differences from the older and more recent Tragulines. The oldest of the Tragulines, moreover, is *Leptomeryx*, a contemporary of *Protoceras*, which has an entirely different skull and foot structure.

Taking all these facts together, we are led to support Prof. Marsh's conjecture, based upon the comparatively hornless female skull, that this Artiodactyle represents a new family, the *Protoceratidæ*. We know absolutely nothing either of the ancestors or successors of this type; and this is another illustration of the fact which is constantly being impressed upon us, that our fossil-bearing strata still contain a great number of forms which are at present wholly unknown and unsuspected.

HENRY F. OSBORN.

HENRY F. BLANFORD, F.R.S.

MR. H. F. BLANFORD, whose death was noticed in last week's NATURE, was born in Bouverie Street, Whitefriars, in the City of London, in 1834. He was one of the students who entered the Royal School of Mines at its commencement in 1851, and after distinguishing himself by taking the first Duke of Cornwall's Scholarship, he studied for a year at Freiberg in Saxony. In 1855 he and his brother, Mr. W. T. Blanford, received appointments on the Geological Survey of India, and they landed in Calcutta at the end of September in that year. Mr. H. F. Blanford remained on the Geological Survey till 1862, when he resigned, his health having suffered from the exposure incidental to geological surveying in India. His most important work whilst engaged on the Survey was the examination of the cretaceous beds of the neighbourhood of Trichinopoly, his classification of which, founded to a considerable extent on palæontological data, has been thoroughly confirmed by Dr. F. Stoliczka's well-known description of the fauna. Mr. Blanford had previously, during his first season's work in India, by separating the Talchir strata, with their remarkable boulder bed, from the true coal-bearing, or Damuda rocks, taken the first step in what for so long was one of the most difficult tasks set before the Indian Geological Survey—the stratigraphical arrangement of the complex of beds subsequently known as the Gondwana system.

On leaving the Geological Survey he was offered a post in the Bengal Educational Department, and from 1862 to 1874 he was one of the professors of the Presidency College, Calcutta. Soon after 1862 he began to take a keen interest in meteorological questions, and after being for some time a member of a meteorological committee nominated by the government, he was, in April 1867, appointed Meteorological Reporter to the Government of Bengal, and placed in charge of an office established with a twofold purpose, to give storm warnings for the protection of shipping and to collect and record systematic meteorological observations throughout the Bengal presidency. Within a short time one most important result was obtained; the meteorological conditions under which cyclones originated in the Bay of Bengal were definitely ascertained, and it became practicable to say when a storm was a probable event, and in what part of the Bay it might be expected, and when a cyclone was impossible, although high winds might prevail. Meantime the various observatories of the country were being brought into order, and the observations rendered systematic.

In 1874 the Government of India became convinced of the necessity for placing all the meteorological observatories in India in communication with a central office, and Mr. Blanford was finally transferred from the educational staff of Bengal and made chief of the new meteorological department, with the official designation of Meteorological Reporter to the Government of India. The new post involved much travelling to visit out-stations, in order to ensure the exact comparison of barometers and other instruments. The organisation of the new department, however, progressed rapidly, and in a few years a series of papers from Mr. Blanford's pen on rainfall, wind directions, and other meteorological phenomena gave evidence to all interested in the science that valuable additions to it were being made by the Indian observations. The peculiar geographical conditions of India render its meteorology unusually simple, and of great scientific and practical importance. An admirable illustration, both of the peculiarity of Indian meteorology and of the practical results yielded by accurate observations, is afforded by the fact that no sooner was the whole system in working order, than it was found practicable some time before the commencement of the monsoon season, and of the rainfall, upon which in many provinces plenty or scarcity of food depends, to prepare a forecast of the approaching season, and to warn the Government of a possible deficiency of rain in particular parts of the country. The forecasts prepared have been found remarkably accurate.

Mr. Blanford retired from the Indian Service in 1888,

and has since resided at Folkestone. Of late his health has gradually given way, and he died on January 23, at the age of fifty-eight. He was elected a Fellow of the Royal Society in 1880, and was an honorary member of several foreign meteorological societies. He was President of the Asiatic Society of Bengal in 1884–85.

That he was a man of considerable intellectual power is shown by the somewhat unusual range of scientific questions on which he has left works and papers. Besides his geological and meteorological reports, he wrote for the Indian Geological Survey descriptions of the *Nautilidæ* and *Belemnitidæ* of the South Indian cretaceous rocks, and he assisted the late Mr. J. W. Salter in describing the Palæontology of Niti. He was also author of several papers on recent mollusca; and amongst his works are two treatises, one on the "Physical Geography of India," largely used as a text-book in Indian schools, and the other "An Elementary Geography of India, Burma, and Ceylon," published as one of Macmillan's Geographical Series.

NOTES.

WE learn from Sydney that steady progress is being made with the Macleay Memorial Volume, and that it will probably be ready for issue about the end of March.

AN announcement comes from Chicago that Mr. Eadweard Muybridge, who, it will be remembered, visited this country some time since on behalf of the University of Pennsylvania, will give at intervals, from May to October, in the "Zoopraxographical Hall of the Exposition," a series of lectures on the science of animal locomotion, especially in its relation to design in art.

ON Thursday next, February 9, Prof. Patrick Geddes will begin, at the Royal Institution, a course of four lectures on the factors of organic evolution; and on Saturday week, February 18, Lord Rayleigh will begin a course of six lectures on sound and vibration.

A TRANSLATION of Prof. Weismann's new work on "The Germ-plasm," recently noticed in NATURE, will appear in the "Contemporary Science Series" in the course of a few weeks.

LAST week a deputation, representing the New Decimal Association, the Chambers of Commerce and Trades Unions, as well as various scientific institutions, waited upon Sir William Harcourt, Chancellor of the Exchequer, to urge the Government to adopt the decimal and metrical system of weights, measures, and coinage, or to appoint a committee of inquiry into the subject. Mr. S. Montagu, M.P., as president of the New Decimal Association, having introduced the deputation, said that forty years ago there was great apathy upon the subject, but since then there had been inquiries by Select Committees and Royal Commissions into the question of the decimal currency, and though the reports of those bodies were satisfactory, no action had followed. The system had been adopted in Germany, Austria-Hungary, and Scandinavia; and in England there was now a good popular demand, such as Mr. Goschen said six years ago he was waiting for. Men of science like Lord Kelvin, Sir Henry Roscoe, and Sir John Lubbock, and educationists like Sir Philip Magnus and Dr. Gladstone desired the reform in order to economise brain-power; representatives of commerce desired it to assist them in their competition with rival nations; and the working classes were awake to the fact that years of labour were wasted by their children being compelled to learn that which could be rendered unnecessary. Several members of the deputation, including Sir Philip Magnus, having spoken, Sir William Harcourt replied. He said that every one who reflected on the question must see the great advantages which attach to the decimal system. But the practical difficulties in the way of the proposed change seemed to him for the present to be insurmountable. A decimal system was introduced into Europe by the French Revolution. That was a time when the whole of society was cast into the melting pot, and they changed, not only their notation, not only their metrical system, but the names of the months and the days of the week. The change in Germany took place, not in quiet times, but as a result of the unification of Germany. He believed that even in the United States of America the change was made consequent upon the establishment of the Federal system. He did not think that the habits of the people could be altered in quiet times. This applied very much to the measures as well as to the coinage. Sir William was ready as an individual to play his part in forwarding the progress of the decimal system and the metrical system; but the Government could do nothing in the matter. The people would have to be prepared for so great a change.

IT is worth noting that instruction in the principles of the decimal and metric systems is daily given in public elementary schools, and that this labour—as Mr. J. H. Yoxall, secretary of the National Union of Teachers, has pointed out in a letter to the *Times*—is imposed upon the children without hope of practical good to the community. Mr. Yoxall contends that if an Act of Parliament were to fix a date of five or ten years hence at which the decimal system should come into legal operation, the work of the schools and the precaution of the mercantile classes would by that time sufficiently prepare the way.

A DESTRUCTIVE earthquake occurred on Tuesday morning at the town of Zante. Several houses were totally destroyed, many more were partially wrecked, and there is hardly a building in the town which has not sustained damage in one form or another. The roof of the prison collapsed during the earthquake, and the guards had to be doubled to prevent the escape of the prisoners. The hospital was also so seriously damaged that it was deemed expedient to remove the patients. The shocks, which were general, were renewed again and again, and the whole population was thrown into a state of panic.

DURING the past week the temperature over these islands has been fairly high, the daily maxima often exceeding 50°, notwithstanding a temporary fall, amounting from 12° to 14° in Scotland and the midland counties of England, on Friday, accompanied by much fog in the south and east of England, while the air has been decidedly humid, the readings of the dry and wet bulb thermometers frequently showing little or no difference. These conditions have been due to deep depressions arriving from the Atlantic and passing in close proximity to our western and northern coasts. In those parts gales have been of almost daily occurrence, and on Sunday they extended as far as the English Channel. Rain has been frequent, but generally the fall has not been heavy, and the sky has generally been overcast and dull, although on Saturday the weather over the south of England was unusually bright and fine. The *Weekly Weather Report* of January 28 shows that the temperature exceeded the mean in all districts, the greatest excess being 4° in Scotland. Bright sunshine also exceeded the mean in some parts of Scotland and in the eastern portion of England, but in other parts of these islands there was a deficiency.

A MAP showing lines of equal magnetic declination for January 1, 1893, in England and Wales, has been very carefully prepared by Mr. W. Ellis, and published as a supplement to

the *Colliery Guardian* of January 6, 1893. The explanatory text states that, as before, the work depends on the magnetic surveys of Profs. Rücker and Thorpe. Mr. Ellis gives a table showing the relation between the diurnal variation of magnetic declination and sun-spots, as determined from the magnetic observations made at the Royal Observatory, Greenwich. The general mean at epochs of minima of sun-spots is 7·4 minutes, and at epochs of maxima 11·4 minutes of arc, and other magnetic elements show a similar relation. The period between successive epochs of maxima or of minima of sun-spots is well known to be on the average about 11 years, and the author points out the curious fact that the interval between the minimum and maximum is on the average 4½ years, whilst from maximum to minimum it is 7 years. The relation existing between sun-spot maxima and minima and the diurnal magnetic variation has led many meteorologists to seek for some similar connection with meteorological phenomena, but Mr. Ellis states that no such relation has yet been conclusively established.

THE report of the administration of the Meteorological Department of the Government of India in 1891–92 shows continued activity and efficiency in all departments of the work, and bears testimony to the interest taken both by the public and by the *employés*. The number of observatories maintained by the Government at the end of the year was 165. As regards the actinometric work, an unusual amount has been done, owing to the favourable state of the weather, and the results have been forwarded to the Solar Physics Committee in London. The rainfall data are published month by month, and a large number of unsatisfactory rain gauges has been replaced by new ones. A larger amount of work under the head of marine meteorology has been done than in any previous year; several clerks are continually employed in collecting data from ships entering the various ports, and these observations have been utilised in preparing daily weather charts of the whole Indian area for a portion of the year. The systems of storm and flood warnings have been continued as in previous years, and observations have been taken in certain forests, in order to throw light on the influence of forest growth in modifying the distribution and amount of rainfall; a report upon this subject will shortly be prepared. Among the other papers being prepared for publication we note one on the relation between sun-spots and weather as shown by meteorological observations taken on board ships in the Bay of Bengal during the years 1855 to 1878.

AT the meeting of the Royal Botanic Society of London on Saturday a plant of the Sisal hemp (*Agave rigida*) was shown from the Society's gardens. This plant is now extensively grown in the Bahamas and Central America for its fibre. The secretary said that until lately, with the exception of two or three fibre plants, as hemp and cotton, commerce depended upon wild plants for its supplies, but so great was the demand now for fibres for papermaking and other uses that it had been found necessary to grow them specially.

THE Slöjd Association of Great Britain met on Saturday to receive the annual report, to elect officers, and to appoint an examining body. It was agreed that "Sloyd" should be substituted for "Slöjd" in the name of the Association. The system of handiwork which the society is seeking to introduce into schools has already been pretty extensively adopted in this country, especially in the north of England. Mr. Harris stated at the meeting that it was being received with approval in many different parts of the world. He had received communications from Napier, New Zealand, and Lahore, India, as to its adoption in these places.

AN American writer who was present at the Galileo Festival in Padua gives a very interesting account of it in the New York *Nation*. He refers to the speeches delivered in Italian by Sir Joseph Fayrer and Prof. George Darwin, to which we have already alluded. "They were," he says, "much appreciated by the audience: 'Parla bene!' 'Pronunzia bene!' one heard murmured in tones not devoid of surprise." The greatest orator of the occasion, according to this writer, was Prof. Schmurlo of Dorpat, in Russia. "The type of the lonely and ungainly scholar in appearance, he nevertheless spoke a few phrases so ultra-Italian in the ingenious gracefulness of their turn, that the audience went fairly wild with delight."

THE latest instalment of the Transactions of the Institution of Engineers and Shipbuilders in Scotland contains an interesting paper, by Mr. E. G. Carey, on the bridges of the Manchester Ship Canal. The paper is fully illustrated. The author notes that practically the whole of the bridge-work for this canal has been constructed in Glasgow from Scotch steel.

THE Smithsonian Institution has issued as one of its bulletins a full and very useful bibliography of the published writings of George Newbold Lawrence, the well-known ornithologist. The work has been done by Mr. L. S. Foster, who gives also a short sketch of Mr. Lawrence's career. Mr. Lawrence's collection of bird-skins is of great scientific value. It includes about 8000 specimens, and contains some three hundred types of new species of birds. The collection was deposited in the American Museum of Natural History, New York City, in May 1887. Mr. Foster says that the beneficial influence of the labours of Mr. Lawrence, with pen and pencil, on the progress of American ornithology, has been great and undisputed. It is particularly among the avifauna of the West Indies, Mexico, Central and South America, that his most strenuous efforts have been exerted.

IF we may trust a statement made on the authority of the Tokyo News Agency, it is not surprising that Japan is unwilling to be deprived of the privilege of fishing on the Korean coast. The number of Japanese boats engaged in the fishery is said to be no less than upwards of four thousand four hundred, of which about eighteen hundred have licenses. Their annual take averages from a million and a half of *yen* to two million value, and it is estimated that with more diligence and improved methods they might easily bring this figure to three or four millions.

IT is rather surprising that tobacco has been so little cultivated in Australia. The *Agricultural Gazette* of New South Wales, we are glad to see, has taken up the matter, and in its November number devotes to it a comparatively long and interesting paper. The writer of the article thinks that the climate of New South Wales is admirably suited to the growth of tobacco, and hopes that a sufficient quantity of it may hereafter be produced not only to satisfy local demands, but to open up a large and lucrative export trade.

ONE of the curious survivals of ancient prejudices in India is the intense dislike with which many high caste Hindus regard sea-voyages. It is even disputed whether a Brahmin who takes a sea-voyage does not lose caste. The Maharaja of Mysore has not only emancipated himself from this strange notion, but is doing his best to overcome it in others. He lately made a voyage to Calcutta, and took with him a number of orthodox Brahmins, as well as Brahmin officials of state.

MR. WALTER HOUGH, of Washington, notes in *Science* that among the collections from Mexico, Central and South America, exhibited in the Columbian Historical Exhibition at Madrid, he observed a number of oblong polished blocks of hard stone of unknown use, averaging 3¼ inches in length, 2¾ inches in width, and 1¼ inches in thickness. The broad sur-

faces of these stones are plane, bearing a number of grooves parallel to the length, forming ridges like those seen on Polynesian tapa mallets. The implements resemble closely, he thinks, those used by many different peoples in beating out fibrous bark for clothing, paper, &c. Mr. Hough suggests that they may have been used for purposes of this kind in prehistoric times, and that they may give some insight into the manufacture of the paper on which the Mexican codices are painted.

MUD GORGE, on the Hurnai route to Quetta, has been giving much trouble to the engineers engaged in the construction of the new railway. Landslips are frequent, and an unusually bad one has occurred within the last few weeks. On this occasion the hill, according to the *Pioneer Mail*, slipped in such a way "as to lift the rails bodily up and turn them over, sleepers uppermost." The mountain is said to be a great porous mass of clayey soil with large boulders imbedded therein, and it sucks in moisture like a sponge. After heavy rain it begins to move downwards, and even in dry weather disintegration goes on with disastrous results to the railway. New fissures are reported to have appeared hundreds of yards up the slopes above the line, and each of these indicates that thousands of tons of earth and boulders will sooner or later find a lower level. A committee of experts has been appointed by the Indian Government to examine the mountain thoroughly, and the *Pioneer Mail* truly says that "if they succeed in devising a means to conquer it they will achieve a notable feat in engineering."

DR. LOW, President of Columbia College, New York, has been stating in the American *Educational Review* his impressions as to the condition and tendencies of the higher education in the United States. One of the points on which he strongly insists is that a general college training should be considered necessary before students begin their University education in theology, law, and medicine. "The prophetic eye," he says, "can even now discern the day when a college education will be a condition precedent for entrance into the professional schools of the American university. This will not mean that only college-trained men will make good practitioners in law or medicine, for example, nor that only college-trained men are entitled to a professional education. It will rather mean, I think, that the university will then have fully realised its own obligation to the country to send forth into professional life, in all parts of the land, men of a thorough and wide equipment."

ARCHÆOLOGISTS have observed that in Greek statues the male eye is strongly arched, while the female eye has rather a flattened surface; and referring to accounts by the older anatomists who have affirmed such a difference to exist, they have seen in this a fresh proof of the exact observation of nature by the ancient Greeks. The rule is not without exceptions, for the cornea in the Zeus of Otricoli has quite a flat form. Herr Greef recently set himself (*Archiv für Anat.*) to inquire whether such a sexual difference actually exists, and from individual measurement of the radius of the cornea in the horizontal meridian, he gets an average of 7·83 mm. for men, and 7·82 mm. for women (Donders gives 7·858 and 7·799), so the difference is so small as to be imperceptible to the naked eye. Measurement of other dimensions gave but minute differences also. The author concludes that the Greeks (from artistic motives) did not in this case follow nature.

THE difference between the aspect of the sky at full moon and the clear and deep azure observed on a moonless night is explained by M. Clémence Royer in his "Recherches d'Optique Physiologique et Physique" on the basis of some observations made by M. Piltschikoff. In studying the polarising action of the moon on the atmosphere, the latter found that the proportion of polarised light in the nocturnal sky diminishes continuously from the time of the full moon up to that of the new moon, when it becomes zero, subsequently to increase again until the time of full moon. There appears to be a struggle between the polarised light of the moon and the so-called natural light of the stars, and the proportion of polarised light sometimes reaches 62 per cent. The diffusing power of the atmosphere necessarily varies with the relative proportions of natural and of polarised light, since the latter is not capable of reflection in all directions. Hence we see why very serene but moonless nights may yet be relatively very clear, and the sky of a beautiful sombre blue, whereas the white light of the moon, reflected, diffused, and polarised, tends to give the sky a tint of a paler and somewhat greyish blue.

AT the last annual meeting of the American Association of Official Agricultural Chemists, the Proceedings of which have just been issued, Mr. N. T. Lupton referred in his presidential address to the immense phosphate beds in the south-western part of Florida. Last winter a visit was paid to some of the localities where deposits are found, and samples were collected for analysis. They were of two varieties, which may be called hard and soft. The hard variety consists of boulders of moderately hard rock, some of immense size, cemented together with white clay. A white and friable mass resembling kaolin is occasionally found. This is probably produced by the natural disintegration of the hard rock by rolling, attrition, or concussion. The deposits vary in thickness. A depth of 20 or 30 feet is not uncommon, and even a thickness of 50 feet has been found. As some, especially foreign, manufacturers object to buying phosphates which contain over 3 per cent. of oxides of iron and aluminium, large quantities of these materials have accumulated at the mines. A few manufacturers, aware of the agricultural value of South Carolina floats, have established mills in Florida for pulverising these soft aluminous deposits, which are sold to farmers for use without conversion into soluble phosphates. Experiments are now in progress on the Alabama Experiment Station, under control of the chemist, to determine the chemical composition and agricultural value of these soft phosphates when used alone with cotton seed and with cotton-seed meal. If decomposing organic matter, as is believed, renders insoluble phosphates available as plant food to any considerable extent, Mr. Lupton thinks that the question of cheap phosphates will be solved, and that the American farmer will be enabled to purchase fertilisers at a much less cost than at present.

MESSRS. W. H. ALLEN AND CO. have issued the thirty-seventh thousand of Dr. M. C. Cooke's "Manual of Structural Botany." The book is intended for the use of classes, schools, and private students.

THE February number of *Natural Science* includes, among other things, articles on some problems of the distribution of marine animals, by Otto Maas; on Pasteur's method of inoculation and its hypothetical explanation, by G. W. Bulman; the industries of the Maoris, by J. W. Davis; some recent researches on insect anatomy, by G. H. Carpenter; parasites on algæ, by G. Murray; the underground waste of the land, by H. B. Woodward; Owen (concluded), by A. S. Woodward; and the restoration of extinct animals.

THE following are the arrangements for science lectures at the Royal Victoria Hall during February:—Feb. 7, Mr. J. Scott Keltie, on Africa and its people; Feb. 14, Mr. E. Wethered, on interesting objects under a microscope; Feb. 21, Mr. J. T. Leon, on breathing and burning; Feb. 28, Dr. H. Forster Morley, on chemistry of life.

THE additions to the Zoological Society's Gardens during the past week include seven Azara's Opossums (*Didelphys azaræ*)

from the Argentine Republic, presented by Mr. Hill; a Rough Terrapin (*Clemmys punctularia*) from Guiana, presented by Mr. J. J. Quelch, C.M.Z.S.; an American Milk Snake (*Coluber eximius*) from Tennessee, presented by Miss Winifred M. Middleton; a Virginian Eagle Owl (*Bubo maximus*) from South America, deposited; two Mouflons (*Orlis musimon*, ♂ ♀) from Corsica, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE NAUTICAL ALMANAC FOR 1896.—The new superintendent of the *Nautical Almanac* office has introduced a much-needed reform into the first almanac, that for 1896, issued under his direction. The state of the *British Nautical Almanac* has long been severely criticised as being far from the best possible for navigational purposes both in form and contents, and by no means satisfactory from the astronomical standpoint. A letter addressed by the Shipmasters' Society to Dr. Hind, the late Superintendent, in November 1891, pointed out the advantage to navigators which would be offered by a work published at a popular price, and without that astronomical information which is of no use to sailors. Many low-priced almanacs are published, indistinctly printed, and having occasional errors in the figures, and an official trustworthy book was very desirable. In consequence of this representation the almanac is now published in two forms—as the complete almanac of former years, price 2*s.* 6*d.*; and as Part I. of the *Nautical Almanac*, specially suited for the use of sailors, price 1*s.*

The complete almanac has been revised and added to, many of the recommendations of the *Nautical Almanac* Committee of the Royal Astronomical Society, which reported to the Admiralty in 1891, having been adopted. The small short period terms of nutation have been tabulated, and, corresponding to that, additional day numbers are added so as to enable computers to include those small terms in the star corrections. The catalogue of stars from which the moon culminators and stars occulted by the moon are obtained has been revised and enlarged, and the mean places of the stars of this catalogue, which are used during the year, are also included. The elements of the occultations are given in a revised form similar to that adopted in most of the other astronomical ephemerides, so that the circumstances of an occultation for any position on the earth's surface can be computed with facility. There has been a general revision of the constants used.

The small almanac has been arranged by Mr. Downing in conference with the Hydrographer. As the guiding principle in publishing this was the minimum of change in the parts of the almanac which were to be extracted and published separately, there is still much in the volume that is not needed by sailors, but the omission of which would have necessitated the setting up of fresh type and much extra work at the *Nautical Almanac* office. The monthly part is printed unaltered, and consequently contains the sun's and moon's latitude and longitude, which are not required by sailors. The noon ephemerides for the brighter planets, Venus, Mars, Jupiter, and Saturn; the catalogue of mean places of stars, as well as the apparent places of the nine stars used for lunar distances; the eclipse section and the tables for navigation are then given. There is no doubt that the issue of this smaller work will confer a real benefit on the shipping community, and that it will soon win its way to popularity.

In announcing these changes to the Royal Astronomical Society, Mr. Downing expressed the hope of being able, through the economy of time effected by international co-operation in some of the work of the office, to make considerable future additions to the almanac without increasing the burden of the British taxpayer. The duplicate work done at Berlin, London, Paris, and Washington involves much waste of energy which might be more usefully expended: and as a step towards this, Mr. Downing, last summer, arranged with Prof. Newcomb, of Washington, to co-operate in some of the work of their respective almanacs, and the Admiralty have consented to this. It is to be hoped, in the interests of astronomy and of navigation, that the scheme may be greatly extended.

ECLIPSE PHOTOGRAPHY.—The results obtained by M. de la Baume Pluvinel at Salut Isles in 1889 (as given in his lecture which appeared in NATURE last week), when he photographed the corona with photographic actions varying from 185 to 13, and found the photographic action of 30 the most satisfactory; do not agree with those of the English expedition obtained at the same time and place. The photographic actions on the plates exposed with the 20-inch mirror of 45-inches focus, by the late Father Perry, varied from 19·75 to 790· as calculated by the formula given by M. de la Baume Pluvinel, and in every case increase of photographic action gave greater extension of the corona. Mr. Rooney's plates, with the 4-inch lens of 61 inches focus, had been subjected to photographic actions varying from 1·11 to 177·77, and agreed with Father Perry's in giving greater extension with every increase of photographic action. The English results certainly justify the conclusion that greater photographic action is necessary to photograph those faint extensions of the corona which have been seen, but have hitherto eluded attempts to photograph them.

Mr. Burnham's experiments, alluded to by M. Pluvinel, do not assist us in this question. A certain absolute amount of light is necessary to give *any* appreciable photographic effect on the plate, and this seems to be the chief difficulty in obtaining photographs of the external corona. In Mr. Burnham's experiments he had too much light and had to cut down the exposure in order to get faint contrasts, but there was never any question of not having sufficient light to obtain any photographic effect. Captain Abney finds (Phil. Trans. vol. clxxx. A, page 314) that an abrupt change of ½ per cent. in the intensity of light can be detected on a photograph, hence we may look upon a negative as a drawing built up of 200 different shades. Over exposure will of course prevent such faint contrasts as ½ per cent. being detected, and under exposure will enable fainter contrasts to be seen, *so long as the limit of minimum exposure necessary to produce any photographic effect is passed*; but the evidence from the English expedition renders it extremely probable that even with the largest photographic action used this limit was not actually reached with the faintest extensions of the corona.

COMET HOLMES.—Dr. F. Cohn, writing about this comet from the Observatory in Königsberg on January 17, finds (*Astronomische Nachrichten*, No. 3146), with a 6-inch heliometer and a magnification of 65 times, that the nucleus is exactly as a star of the 8th magnitude. The correction to the ephemeris given below is, as he has deduced, $\Delta\alpha = -0^{s}.3$, $\Delta\delta = -6''$.

Dr. R. Schorr, of the Hamburg Observatory, puts the nucleus down on the same date as a 7·2 magnitude star with a small nebulosity about it of 5″ diameter, but on the 18th he found the comet showed a much larger coma, a measurement giving 87″. The stellar nucleus was also estimated as 7·5 magnitude of a diameter 2″.

The ephemeris of this comet is from Prof. Schulhof's calculations (*Astronomische Nachrichten*, No. 3140):—

1893.	R.A. app. h. m. s.	Decl. app. ° ′ ″
Feb. 2 ...	1 45 46·5 ...	+33 49 26
3 ...	47 16·6 ...	50 48
4 ...	48 47·3 ...	52 14
5 ...	50 18·6 ...	53 45
6 ...	51 50·4 ...	55 20
7 ...	53 22·8 ...	56 59
8 ...	54 55·8 ...	58 41
9 ...	1 56 29·3 ...	34 0 28

COMET BROOKS (NOVEMBER 19, 1892).—The following is an ephemeris for Comet Brooks for the ensuing week:—

1893.	R.A. app. h. m. s.	Decl. app. ° ′	Log *r*.	Log Δ.	Br.
Feb. 2 ...	23 56 48 ...	+34 27·7			
3 ...	23 59 13 ...	33 44·4 ...	0·1050 ...	0·1295 ...	1·90
4 ...	0 1 31 ...	33 3·3			
5 ...	3 42 ...	32 24·1 ...	0·1087 ...	0·1482 ...	1·71
6 ...	5 48 ...	31 46·4			
7 ...	7 48 ...	31 10·4			
8 ...	9 43 ...	30 35·8			
9 ...	0 11 33 ...	30 2·9 ...	0·1167 ...	0·1832 ...	1·40

THE ANDROMEDES.—Although Mr. Maclair Boraston was unfortunate in having bad weather on the nights of November 13 and 14 last, thus obscuring the Leonids, yet the magnificent shower of the Andromedes that he describes in *Astronomy and Astrophysics* for January should have recompensed him somewhat for "the great elevation of the radiant point, combined with a cloudless tropical sky, the absence of moonlight and the unobstructed view of the complete hemisphere, afforded the *ne plus ultra* of astronomical requirement." Observing in

longitude 72° west and latitude 17° north, between 11h. 48m. and 5h. 48m. G.M.T., he deduced the radiant point from 70 short-track meteors, and four coincident stationary ones, giving its position as R.A. 28°, decl. +36°. Counts being taken at intervals for areas of 60°, about 18 meteors per minute were recorded, thus making a total number of 108 for the entire hemisphere in one minute, or 6480 per hour. As this fall went on continuously for six hours without any sign of the numbers diminishing, we have the number of meteors 38,880, which Mr. Boraston says must certainly be a minimum, as many faint and rapid ones must have escaped notice. A further observation at 8h. 48m. showed that the action was still being kept up, thus increasing this number to about 60,000. During this display it was remarked that the meteors appeared much brighter when distant from the radiant point than in its vicinity.

A NEW METHOD OF PHOTOGRAPHING THE CORONA.—M. H. Deslandres, in the *Comptes Rendus* of January 23, describes a method of photographing the solar corona without the aid of absorbing media. Sunlight is allowed to fall directly on a system of two identical prisms with parallel and inverted faces placed at a distance apart, such that only a portion of the diverging band from the first is intercepted by the second. After passing through the latter, the rays by recomposition give rise to a well-defined coloured image of the sun's disc. On displacing the prisms in a line perpendicular to the line joining them, the image assumes different colours, and on moving them along it, the range of colours intercepted is made to change. The prisms may be replaced by gratings. In a series of experiments carried out during the autumn, nine successive impressions of the sun's image were taken, ranging from the C line till far into the ultra-violet. The object was to find the region where the light emitted by the corona showed the greatest photographic difference from that of the diffused sunlight in the atmosphere. As a matter of fact, a halo distinctly separated from the diffused sunlight showed itself on some of the negatives, especially in the ultra-violet region, which very probably represented the corona. But to confirm this, simultaneous exposures at different, especially elevated, stations ought to be made, if possible during a total eclipse.

GEOGRAPHICAL NOTES.

THE February number of the *Geographical Journal*, in addition to two important papers read before the Royal Geographical Society, and already reported in NATURE, contains a brilliant account by Mr. Conway of the crossing of the Hispar Pass. The views of mountain scenery were bewildering in their extent; from the foot of the valley an unbroken glacier was in sight, stretching downward from the pass forty miles distant. This unrivalled ice-stream was covered for the lower twenty miles with moraines. From the pass a vast snowfield, surrounded by magnificent rock aiguilles, was seen to lie below, and from this the Biafo glacier descended. From the end of the Hispar glacier to the end of the Biafo glacier was a distance of eighty miles, forming the longest snow-pass in the world outside the Polar regions. Mr. Stephen Wheeler communicates a paper on Mendez Pinto, whose early travels in the East seem to have been unduly discredited.

IT is announced that the eminent geographical author M. Elisée Reclus has accepted a professorship in the University of Brussels, and will commence his work there by a course of lectures on comparative geography.

MR. ASTOR CHANLER'S expedition to Lake Rudolf, by the Tana, has reached Hameye, the Ibea Company's post at the head of navigation on the Tana—a position accessible in five weeks from the coast, to which camels, oxen, donkeys, and horses can be safely taken. Lieutenant Höhnel, who is attached to the expedition, finds that Commander Dundas has placed the Tana from 20 to 22 minutes of longitude too far west, and he has searched in vain for the mountain ranges reported by Dr. Peters.

IN a recent journey of some duration in the Sakalava plain in the north-west of Madagascar, M. Emile Gautier (according to the *Annales Géographique*) found the soil everywhere to consist of a stiff red clay, weathered into steep-sided lumps and chasms overlying sedimentary rocks, but quite similar in colour and character to the red clay which covers the volcanic rocks of the plateau. M. Gautier believes that this clay is identical with the laterite of the Deccan.

MAJOR LEVERSON, the British Commissioner for the delimitation of the frontier between the British South Africa Company's territory and the Portuguese possessions, has returned to this country, after having carried out extensive surveys and made considerable rectifications in the map of a strip of country stretching from the north-east corner of the Transvaal northward to Massikessi. The position of the latter point was fixed as 18° 15′ 33″ S., 32° 51′ 24″ E.

MR. MACKINDER gave the second lecture of his course on History and Geography, under the auspices of the Royal Geographical Society, on Friday evening, when he discussed the road to the Indies, showing how the desert route, which led to the growth of Palmyra, was superseded by the ocean route after the successful rounding of the Cape of Good Hope. The theatre of history in ancient times was the region enclosed between the pine forests of northern Asia and the Indian Ocean, divided into separate worlds by a double belt of deserts and steppes.

THE GROWTH OF ELECTRICAL INDUSTRY.

ON Friday last Mr. W. H. Preece, F.R.S., delivered before the Institution of Electrical Engineers his inaugural address as President. He said he had completed his fortieth year of continuous service in developing the practical applications of electricity for the use and convenience of man, and it appeared to him that he could not better repay the high compliment the Institution had conferred on him by electing him, for the second time, to be its President than by surveying and criticising the growth of the various branches of electrical industry with which he had been more or less associated during that long period. In the course of his address he dealt with telegraphy, submarine telegraphy, lightning protection, railway signalling, telephony, domestic applications, electro-chemical industry, electric lighting, power transmission, electric traction, and theoretical views of electricity.

Speaking of telegraphy, Mr. Preece said:—The instrument that we have principally developed in England is the automatic fast-speed apparatus, based on a principle of preparing messages for transmission by punching, devised by Alexander Bain in 1848, and improved in its mechanical details by Mr. Augustus Ströh in 1866. This has been my special pet, and with the electrical assistance of Mr. J. B. Chapman, and the mechanical skill of Mr. J. W. Willmot, all the ills that telegraphs are heir to have been routed, and the practical speed of working has been multiplied more than six-fold. It has been one long continual contest between patient observation, inventive skill, careful experiment, and technical acquirement on the one hand, and resistance, electrostatic capacity, inertia (electro-magnetic and mechanical), bad insulation, impure materials, imperfect workmanship, &c., on the other. But we have, step by step, won all along the line: 75 words per minute have become 500; a possible 130 has become an actual 600. Duplex automatic working over cable lines is possible, and modes of working have been introduced that were thought at one time chimerical and impossible. . . .

The results to which I have referred have not been attained without very special attention to questions of construction and maintenance of the wires, both aerial and submarine, and a very complete system of test is now applied both before and after every line is completed. In the early days of telegraphic communication very rough and crude tests were applied, and the condition of the lines caused serious difficulties; but at the present day we must ascertain the purity of the metal employed, its mechanical strength, its electrical resistance and capacity, its insulation resistance, and the relationship between the latter and the conductor resistance, as well as its speed value. The employment of copper as the conductor suspended on poles in place of iron, which was inaugurated at my instigation in 1884, by a very costly experiment between London and Newcastle, has had a material influence in increasing the speed of working and improving telegraphy. This is due not only to its reduced resistance, but to the absence of electro-magnetic inertia in a long, single-suspended copper wire. All our long important telegraphic circuits are now built with copper.

One of the arguments used against the proposed transfer of the telegraphs to the State was the notion that invention would not be fostered by a Government department. This has been entirely falsified. Telegraphy has been advanced in this country

more rapidly by the British Post Office than by any private undertaking, and we have certainly shot ahead of our smart cousins on the other side of the Atlantic, from whom, however, I am proud to say, I learnt so much on my visits in 1877 and 1884. Their engineers are looking to us to develop their inventions, and we have done so. They cannot always get them taken up in the States. Diplex, quadruplex, and multiplex telegraphy are importations from them, but they have been improved in our service by our own developments, and have now become the staple and the standard modes of working. No one has done more to effect this object than Mr. M. Cooper.

An accident in the drafting of the Act of Parliament of 1868-69 transferring the telegraphs from the hands of private companies to that of the State, has led to a tremendous development of newspaper reporting in England. Few people are aware of the immense business done for the press. The growth of press messages is shown in the fact that 21,701,968 words paid for in 1871 have grown in 1891 to 600,409,000—an average of nearly 2,000,000 words per day.

When Mr. Gladstone spoke at Newcastle, at the National Liberal Federation, in 1891, 390,778 words were signalled to different parts of the country. This kind of business is not, however, confined to the Post Office. The Exchange Telegraph Company, which commenced operations in 1872, working under the license of the Postmaster-General, has in London over 800 instruments at work (120 being in newspaper offices), distributing a daily average of 3,381,134 words to various receiving instruments adapted to the requirements of the respective services. The financial intelligence, for example, being transmitted over instruments furnished with type-wheels containing the various fractions most in use in Stock Exchange quotations. The latest form of this instrument prints at the rate of forty words per minute. General and parliamentary intelligence are distributed to the clubs over column printers, and legal, sporting, and Parliamentary news to newspapers on specially fast tape printers, capable of delivering, in the hands of skilled operators forty-five full words per minute to any number of subscribers simultaneously. The news transmitted is chiefly commercial and financial, amounting to 2,775,000 words per day.

To return to the purely State telegraphy. Some idea of the growth of the general telegraphic business of the country may be gathered from the following statement, which gives the total number of messages paid for in each year :—

1852	211,137
1869	6,830,000
Transfer took place in 1870.	
1882	31,345,861
1892	70,215,439

In the course of his review of the history of submarine telegraphy, Mr. Preece said :—By far the greatest cable corporation in the world is the Eastern Telegraph Company, whose system of 25,376 miles stretches from Cornwall to Bombay, connects the northern and southern shores of the Mediterranean with Malta, and joins up the various other islands of the Mediterranean and the Levant. This company, in conjunction with the Eastern Extension and the Eastern and South African Companies, also gains access to Australia and New Zealand on the one hand, and to the Cape of Good Hope on the other, the combined mileage reaching a total of no less than 47,151. This enormous system has all grown up within, practically, the last 23 years.

The form of cable has practically remained unaltered since the original Calais cable was laid in 1851. Various sizes of core and armour, and various modes of protection from decay, have been used to suit different routes, but the cable of to-day may be said to be typically the same as that used in the English Channel in 1851, and in the Atlantic in 1865.

The first cable had gutta-percha as a dielectric, and it is still almost exclusively used for submarine cable core ; but the manufacture has so improved in the last twenty years that a core having an insulator weighing 150 lbs. per naut, which then had a dielectric resistance of some 250 megohms a naut at 75° F., can now be obtained, giving 2000 megohms at the same temperature. Indiarubber is creeping in, owing to the high price and scarcity of gutta-percha.

Next to strong tides, rocky bottoms, anchors, and shallow water, the greatest enemy to submarine cables, more especially in the tropics, has proved to be the teredo of various species ; but this depredatory worm has been utterly routed by covering the gutta-percha core with a lapping of thin brass tape laid on spirally. A remarkable thing about this little insect is that, whereas twenty years ago it was practically unknown in our English waters, it has now gradually spread all round our coasts, with the exception, perhaps, of the North Sea. A new cable about to connect Scotland and Ireland is being served with brass tape.

With the cables has grown up a fleet of telegraph ships to lay and maintain them. In 1853 the *Monarch*, belonging to the Electric Telegraph Company, was the only ship permanently employed as a repairing telegraph ship ; now, in 1893, the cable fleet of the world numbers no less than 37, of which seven belong to Government administrations and the rest to private companies, the Eastern Telegraph Company heading the list with five vessels.

Perhaps the most remarkable history of a cable is the following :—In 1859 the light cables laid in 1853 from Orfordness to Holland were picked up and replaced by a heavier one. A few nauts were sold to the Isle of Man Telegraph Company, and had an extra sheath laid on. This cable was submerged between that island and St. Bees, where it remained until 1885, when it was replaced by a three-core cable. It was again put under water in 1886 as part of the cable between Uist and Harris, in the Hebrides, where it still lies, as good as ever. The durability of submarine cables is remarkable. That laid between Beachy Head and Dieppe in 1861 is still working ; and that laid between Beachy Head and Havre in 1870 has broken within the last month for the *first* time.

Despite the enormous growth of submarine cables during these forty-two years, there would appear to be plenty of scope for still further extension. The Pacific still remains untouched, and the project is at the present time under consideration to connect our possessions in North America with those in Australia.

The following is the passage relating to telephony :—I had the good fortune in 1877 to bring to England the first pair of practical telephones. They had been given to me in New York by Graham Bell himself. After a series of experiments, I brought them before the British Association meeting, which was held that year at Plymouth. Who at that time could have imagined that the instruments, which were then but toys, would, within sixteen years, have become a necessity of commercial, and almost of domestic, life ? Yet to-day the number of telephones in actual use may pretty safely be put down at a million !

During 1878 Edison devised his carbon transmitter, and Prof. Hughes presented his "microphone" to the world. These inventions made the telephone a practical instrument of vast commercial importance. It may be said to have sprung into existence well-nigh perfect ; and the fewness of the actual improvements on the Bell receiver and the Hughes microphone is scarcely more astonishing than the immense number of fruitless attempts at improvement that have been made. Even now the original instruments are not easily beaten.

The institution of telephone exchanges has led to a development of systems of switching that might fairly be considered a special study in themselves, and the demand for communication between distant places has necessitated the application of much special attention to the method of constructing lines and of arranging circuits.

It is in this latter field that I have been a diligent worker, and the application of the so-called "K R" law has proved of material benefit in connection with the problems of long-distance telephony. It is a law which implies that the number of signals that can be transmitted per second through any circuit depends solely on the capacity (K) and the resistance (R) of the circuit. It is very much the fashion to deny the accuracy of the K R law. This is probably the result of ignorance of its meaning or of its interpretation. Some speak of it as empirical, others scoff at it as imaginary, and some sneer at it as an impossible law ; but it is a law that has determined the dimensions and speed of working of all our long submarine cables ; it determines the number of arms a circuit can carry on the multiplex system, the speed attainable with the Wheatstone system, and the distance to which it is possible to work quadruplex ; it is a law that has enabled us to bring London and Paris within clear telephone speech of each other, and which will probably before the year is out enable Dublin and Belfast to speak to London—a message

of peace to Ireland as solid and substantial as any promised political proposal.

The New York and Chicago trunk line is 950 miles long, and it is built with 435 lbs. (or No. 8 S.W.G.) copper wire. This wire gives a resistance of 2·06 ohms per mile, which is easily verified; but it is said by Mr. Wetzler to have a capacity of 0·0158 microfarad per mile, which cannot be verified, and which is absurdly high. 0·0158 microfarad was a measurement made by me in England on an old line, but I have frequently pointed out that owing to the use of earth wires the capacity of our English lines is very much greater than that of American lines. Mr. Edison discovered this in 1872 when he came to England to introduce his automatic system. Moreover, I have also pointed out that induction still further diminishes this capacity. The Paris circuit does not exceed 0·005 microfarad per mile. I should estimate the Chicago circuit at 0·004 microfarad per mile, and the K R at 7500, which gives a result that quite accords with the opinions that I have heard expressed by those who have tried the two circuits as to the relative efficiency of the Paris and Chicago lines. My American friends would have done better if they had used thicker wire. I should have specified 600 lbs. per mile; but if it had been in England I should have used 1000 lbs., for we cannot dispense entirely with cables and underground work as they have done in the States, and the increased capacity introduced must be compensated for by reduced resistance. As a matter of fact, I once proposed 1200 lbs. wire for a circuit between London and Berlin—a distance of 760 miles, including a cable 55 miles long.

The beneficial effect of induction as a negative capacity is observed when working a circuit telegraphically with automatic high-speed apparatus. Thus, on two copper wires 450 miles long, making 900 miles altogether, the speed on each single wire was 120 words per minute, and on metallic circuit—

Loop *viâ* different routes ... 120 words per minute.
,, on same poles ... ... 150 ,, ,,

So that the improvement effected by induction was 25 per cent.

There is no difficulty in measuring R of a metallic loop. The Wheatstone bridge determines it at onee. There is more difficulty in obtaining K. It cannot be measured directly. But with a metallic loop of copper, partly overhead and partly underground, there are several modifications required, due to electrostatic and electro-magnetic induction, which are at present beyond the reach of formulæ, and render it difficult to determine the capacity except approximately from the telephonic effects themselves. Thus the capacity on the London-Paris circuit proved to be only one-half of that obtained by calculation, and every long circuit will require its own K to be determined by comparison with an empirical K R scale. Such a scale I have determined by careful experiment on artificial cables.

I have recently devised a new form of cable which will probably quadruple the rate of telegraph working to America; and I may say with all confidence that there is no theoretical reason whatever why we should not converse between London and every capital in Europe, while it is not impossible to speak even across the Atlantic.

With regard to electric lighting, Mr. Preece said that many efforts are being made to utilise the waste forces of nature in producing electric currents for the economical supply of the light. In America, Scotland, Switzerland, Italy, and, indeed, wherever waterfalls are available, electric plant is being installed to convert the energy of the fall into the useful form of electricity. At Tivoli, near Rome, a fall of 165 feet is used to work six turbines of 350 horse-power each, giving 2100 horse-power in all. Six high-pressure alternators working in parallel send electrical energy at over 5000 volts pressure to Porta Pia, near Rome, 14·8 miles from Tivoli, through four stranded copper conductors, each having a diameter of 13mm., and bunched into one metallic loop, giving a total resistance of 4 ohms. At Porta Pia the 5000 volts are reduced to 2000, and the currents are distributed to several substations spread over the city, where they are again lowered to the safe pressure of 102 volts, at which voltage the current is supplied to the consumer on the three-wire system. There are 600 arcs and 30,000 glow lamps in use in Rome, but they are not all supplied from Tivoli. Mr. Preece inspected this installation only a few days ago, and found everything working smoothly and efficiently under the able guidance of Prof. Mengarini.

Water power abolishes the coal bill, but it must be remembered that the cost of maintenance of machinery and of the erection and upkeep of conductors limits the distance to which the energy of falling water can be economically transmitted. The proposal to light New York by currents generated at Niagara is at present financially absurd. It is doubtful whether it will be commercially advantageous at Buffalo, 30 miles away, but it is certain that at Tivoli it can be so applied with advantage and profit.

There is much water power in this country that might be usefully employed. At Worcester it is proposed to use the water of the Teme, a tributary of the Severn, to supply electrical energy to the city—an experiment that will be watched with considerable interest, for the use of water power will solve the difficulty occasioned by light loads during the small hours and daylight. Keswick and Lynton have already been so served, but on a small scale only. There are many towns whose public streets could be brilliantly illuminated by the streams running past them, but there is much fear and distrust to be removed from the minds of our local magnates, and a considerable amount of education necessary before the public will receive the full value of the gifts that nature so freely places at its disposal, and the engineer so thoroughly converts into a utilitarian form.

The following are some extracts from the passage in which theoretical views of electricity are discussed:—

In the Presidential address which I delivered to the Society of Telegraph Engineers and Electricians in 1880, I took the opportunity to formulate the theoretical views of electricity that I had acquired at the feet of Faraday. It is not given to every boy to have his great ambitions realised. One of my ambitions as an earnest listener to Faraday's simple and delightful lectures was to be his assistant, and in almost the last investigation he undertook on electric induction in underground wires it was my privilege to see much of him, and to prepare many experiments for him. Early in 1854, at his wish, I carried out for Mr. Latimer Clerk certain experiments on the comparative effect of increments of voltage in increasing the rate of transmission of signals through long telegraph circuits. It was found that variation of voltage had no effect. Currents from 31 and from 500 cells sent through 768 miles of gutta-percha-covered underground wire showed precisely the same velocity. These experiments were sent by Faraday to Melloni, who had prompted the wish, and Melloni ("Faraday's Researches," vol. iii. page 577) remarked: "The equal velocity of currents of various tensions offers a fine argument in favour of the opinion of those who suppose the electric current to be analogous to the vibrations of air under the action of sonorous bodies." This is to be found in the very last contribution inserted in the greatest work ever published on our science, "Faraday's Experimental Researches in Electricity."

Faraday's views were subsequently expounded and extended by Maxwell, who said: "Faraday, in his mind's eye, saw lines of force traversing all space, where the mathematician saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids" (Maxwell, "Electricity," vol. i. page 10).

Since that period I have never regarded electricity as anything else but as a form of energy, and its effects as modes of motion of the molecules of matter and of the ether that fills all space; and during my long apprenticeship of forty years I have never examined one experiment or considered one fact that was not explicable on this theory. . . .

Electricity is energy which is transmitted by matter and through space by certain disturbances the result and the equivalent of work done, and in certain orderly and law regulated forms, called "electro-magnetic waves." It is not difficult to conceive the ether carved or the molecules of matter swayed or excited in definite periodic waves. A molecule is subject to all kinds of motion—translation, oscillation, rotation upon its own axis, and revolution about some external axis. Clausius (*Pogg. Ann.*, clvi. p. 618) suggested that the atoms or groups of atoms constituting a molecule revolve around one another similarly to planets, and are sometimes nearer to and sometimes further from each other. The difference between the infinitely great and the infinitely little is only one of degree. The motions of the solar system and that of a molecule of water are similar. These motions are imparted to and transmitted by

the ether, and they are taken up again by matter. One kind of wave gives us light, another radiant heat, another magnetism, and another electrification. The rate at which these waves move is the same, viz. 30,000,000,000 centimetres, or 192,000 miles, per second. It is only their form and their frequency that differ. Matter and ether are subject to strains, currents, vortices, and undulations, and every single electro-magnetic phenomenon can be compounded of or reduced to one or other of these mechanical disturbances. Rotation in one direction gives positive electrification: rotation in the opposite direction gives negative electrification. A whirl in one direction gives us north magnetism; in another direction, south magnetism. Hertz, the experimental exponent of Maxwell's views, has shown the existence of electro-magnetic waves, and has proved their reflection, refraction, and interference. The rate of their propagation is the same in ether, air, and conducting wires.

The most recent discoveries and deductions are all in accordance with this mechanical theory. J. J. Thomson's views that at high temperatures, in the act of dissociation, all gases, and Dewar and Fleming's conclusion that at low temperatures—in fact, at the absolute zero of temperature—all metals become perfect conductors, might almost have been predicted. Hysteresis and Foucault losses are mere wastes of energy, due to molecular friction or to internal work done on the molecules, assisted by bad design and impure material; but, being measurable and comprehensible, their reduction to a minimum has become possible and actual.

It is a misfortune that a beautiful hypothesis like Maxwell's electro-magnetic theory of light has been discussed almost solely by mathematicians. Its consideration has been confined to a small and exclusive class. It has not reached the public; and this is to be regretted, for, after all, it is the many, and not the few, that determine the acceptance or refusal of a theory. The existence of the ether is now thoroughly comprehensible. Light is now regarded as an electro-magnetic disturbance. The eye is an extremely sensitive and delicate electro-magnetic instrument. The difference between luminous, thermic, and electro-magnetic waves is one of frequency and form. We thus have to consider the propagation of these waves not only in the conductor and in the dielectric in the direction of the circuit itself, but in the ether at right angles to this direction. The former produces currents in the conductor, and the latter induction and secondary effects in contiguous conductors. Thus it is easy to see why electric and magnetic lines of force are at right angles to each other, and each of them perpendicular to the line of propagation of the primary electro-magnetic wave, and why the transversal disturbances are secondary waves of electro-magnetic energy which can be transformed into electric currents of opposite direction whenever contiguous conductors lie in their path so as to be cut by these lines of force in the proper direction. Induction is thus mere transformation of energy whose direction and magnitude are easily calculated.

It is by following out this line of thought that I have recently succeeded in sending messages by Morse signals across the Bristol Channel between Lavernock and Flat Holm, a distance of 3·1 miles. The electro-magnetic disturbances were excited by primary alternating currents in a copper wire, 1237 yards long, erected on poles along the top of the cliff on the mainland. The radiant electro-magnetic energy was transformed into currents again in a secondary circuit, 610 yards long, laid along the island. The strength of these secondary induced currents complied almost exactly with calculations. The results attained, the apparatus used, the precautions taken to separate effects of induction from effects of conduction; the elimination of mere earth currents from electro-magnetic disturbances in air, will form the subject of a separate paper, for their proper consideration would be too tedious for an address. I allude to them now only to illustrate the existence of one of the greatest proofs of the truth of a theory, viz. the practical development and verification of a conclusion predicted from mere theoretical considerations.

The oscillatory character of the discharge of a Leyden jar, which was discovered by Henry in 1842, is an admirable proof of this molecular theory. If two jars, precisely similar as regards capacity and circuit inertia, be placed near each other with their planes parallel, and one of them is charged and discharged, the other responds sympathetically, as do two similarly pitched tuning-forks when one is excited. Professor Oliver Lodge, who has made this field his own, has shown that by varying the capacity of the jars and the inertia of the circuit, oscillations can be produced to give any required rate of oscillation from one to 300 millions per second.

In a room or theatre, when these discharges are excited, it is a common thing to see sympathetic sparks upon the spangled walls, and among the metallic objects scattered about. The whole place is an electric field, which is violently disturbed at every spark, and everything which is "syntonised," as Oliver Lodge calls it, to the main discharge, responds in this way.

It is impossible to account for these effects, which are all cases of transformed kinetic energy, except on the mechanical theory which I have advanced. We have a source of disturbance, we have energy transmitted in waves, we have wave transformed into disturbance again. Energy passes through its various stages by the motion of matter and the action of the ether. Everything is accounted for and nothing is lost. Waste energy only means energy in the wrong place.

YEZO AND THE AINU.

TWO papers on recent travels in the Island of Yezo were read to the Royal Geographical Society on Monday evening. Prof. J. Milne, F.R.S., whose paper was read by the Secretary, made a journey to the north-east of the island by sea in 1891, and returned by land, crossing Yezo almost through its centre. He was accompanied by Mr. John Revilliod, and travelled with a view to studying the volcanic geology of the regions. Landing at Kushiro, interesting on account of the relics of pre-Ainu inhabitants, and on account of its coal mines, they ascended the Kusuri river to Shibecha, where there is a great convict prison and sulphur refinery, the raw sulphur being obtained from the volcano Atosanobori, to which there is a railway twenty miles long. In this locality the violence of the escape of steam from the boiling springs exceeds anything seen elsewhere in Japan, New Zealand, or Iceland. A new road, thirty-seven miles long, led from the volcano to Apashiri, on the north-east coast, where a factory for making matches has recently been erected, on account of the abundance of the white-stemmed poplar, the timber of which is much more readily worked in the fresh state than when dried. A boat journey was made in a small dug-out canoe under rugged cliffs from 500 feet to 1000 feet in height, for thirty miles to Shiritoki, where there is a great sulphur mine. From some of the volcanic craters fused sulphur flows like lava, and crystallises in an almost pure state. A trip from Nemuro to the nearer Kurile Islands was followed by the main feature of the journey, a ride from Yubets, on the north coast, up the Yubets river, across the watershed, and down the Ishikari river, to the west coast. Groups of convicts working on the new roads, which are being made across the island, were almost the only people met with. Vast groves of tall bamboo grass everywhere impeded the travellers, and insects of all kinds proved very troublesome. There was little or no sign of larger animal life.

Mr. A. H. Savage Landor also read a paper. He had wandered all round Yezo and up several of the largest rivers quite alone, and with no object save curiosity and the desire to study the Ainu at home. The main part of his equipment was a great store of painting material, of which he made good use in portraying both the natives and the scenery of the island. The Ainu accessible from Hakodate, who have been frequently visited and often described, are almost all Japanese half-breeds, and much influenced in customs and costume by their southern neighbours. The Ainu of the interior and the more distant parts of the coast were very different. The true Ainu villages are intensely filthy, and the vermin in them make life almost unsupportable to a stranger, minute black flies, which swarm in incredible hosts, being the worst. The people, although good-humoured, are sunk in the most degraded savagery. Their marriage customs seem to be summed up in unqualified promiscuity, the Ainu disclaiming any idea of being better than bears or dogs. The Ainu language is poor in words, and many of them show a curious resemblance to words of Anglo-Saxon origin, *e.g.* *Chip*, for ship; *Do*, day; *Mukku*, music; *Pone*, bone; *Ru*, road; *To*, two; *Wakka*, water. The religious beliefs of the Ainu can hardly be dignified by such a term; they are merely superstitions. In travelling along the south-west coast there was often considerable danger from the waves washing over the narrow track which wound between the boulders on the beach. Fog prevails along the east coast in summer, probably on account of the Kuro-Siwo encountering a cold current off the island. The upper Tokachi river was the

most remote part of Yezo visited, a region which had scarcely been traversed by the Japanese. Here the Ainu were found to be more hairy than elsewhere, and to present many Aryan features in their general appearance. One peculiar fact brought out by many measurements was the remarkable length of their arms. The measurement across the outstretched arms is always from three to five inches more than the height of the individual. The future capital of Hokkaido (the name given to Yezo and the Kurile Islands collectively) is to be erected on the Kamikawa plain, in the very centre of Yezo, and roads are being pushed forward to connect it with all parts of the coast. It will, when completed, take the place of the present capital, Sapporo. According to Japanese maps, Mr. Landor's journey extended to 5000 miles, but his own reckoning puts it as 3800; almost the whole distance was done on horseback.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—By the death of Prof. Westwood on January 2 the University lost one of the most learned of its members, and another link with the earlier study of science in Oxford is gone. Prof. Westwood became Hope Professor on the foundation of the chair by the Rev. F. W. Hope in 1861, and afterwards devoted his time to the perfecting of the collection which Mr. Hope bestowed on the University. The collection, which has received considerable additions from other sources, including the Burchell collection, Wallace's types, &c., has attained somewhat unmanageable proportions, and its present quarters are too small for its proper display. Whoever succeeds to the chair, it is to be hoped that suitable provision will be afforded to enable him to make the collection of more use to University studies than has hitherto been the case.

In November last an examination for a Radcliffe Travelling Fellowship, thrown open, *pro hac vice*, to all branches of natural science, was held, but the result has not yet been announced. It is now announced that an examination will be held during this term for a second Radcliffe Fellowship, the subjects being strictly medical. It is believed that the results of the two examinations will be published together at the end of this term. There is some dissatisfaction at the delay in announcing the result of the first examination.

Prof. Ray Lankester has recovered from the illness which necessitated his absence from Oxford last term, and has resumed his lectures on the Vertebrata and a senior course on the Arachnida.

The Mathematical Scholarships and Exhibitions have been awarded as follows:—

Senior Mathematical Scholar, R. C. Fowler, B.A., of New College.

Proxime Accessit, S. F. White, B.A., of Wadham College, to whom the Examiners have awarded Lady Herschell's book.

Junior Mathematical Scholar, C. B. Underhill, Balliol College.

Junior Mathematical Exhibition, J. F. McKean, Hertford College.

Proxime Accessit, W. C. Childs, Corpus Christi College.

The Duchess of Marlborough has bestowed on the Chemical Department the entire collection of chemical and electrical apparatus belonging to the late Duke. The collection, which includes two exceptionally fine spectroscopes, delicate balances, &c,, has been brought to the Museum from Blenheim, and forms a valuable addition to the Chemical Laboratory.

Mr. E. L. Collis, of Keble, is President, and Mr. M. D. Hill, of New College, is Treasurer of the Junior Scientific Club this term, and Messrs. C. H. H. Walker, of University College, and T. H. Butler, of Corpus Christi, are respectively Chemical and Biological Secretaries. The first meeting is held on Wednesday, February 1, when Mr. J. E. Marsh exhibits some products of the electrical furnace, and Messrs. Finn and Fremantle read papers on East Africa and Hermaphroditism.

At a meeting of the Biological Club, on Saturday last, Mr. G. C. Bourne read a paper on the influence of the nucleus on the cell.

CAMBRIDGE.—The Senate have resolved to appoint a Demonstrator in Palæozoology in connection with the Geological Department. He will have no stipend from the University, but will be remunerated from the fees paid by students.

Dr. Allbutt, Regius Professor of Physic, Dr. A. MacAlister, Professor of Anatomy, and Dr. Donald MacAlister, University Lecturer in Medicine, have been appointed to represent the University at the Eleventh International Medical Congress to be held at Rome in September next.

Dr. W. H. Gaskell has been appointed a member of the Special Board for Medicine, and Mr. C. T. Heycock a member of the Special Board for Physics and Chemistry. Dr. Ransome, F.R.S., Honorary Fellow of Gonville and Caius College; Dr. Corfield, F.R.S, Professor of Hygiene and Public Health in University College, London; Dr. J. Lane Notter, Professor of Military Hygiene at Netley; and Dr. Thorne Thorne, F.R.S., Medical Officer to H.M. Local Government Board, have been appointed Examiners in State Medicine for the Diploma in Public Health during the current year.

Sir G. G. Stokes and Dr. Hobson have been elected Examiners for the Adams Memorial Prize to be awarded in 1895.

Mr. E. H. Acton, of St. John's, and Mr. T. H. Easterfield, of Clare, have been approved as Teachers of Chemistry with reference to the regulations for medical and surgical degrees.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1892.—"Experiments on the Action of Light on *Bacillus anthracis*." By Prof. Marshall Ward, F.R.S.

It is abundantly evinced by experiments that direct insolation in some way leads to the destruction of spores of *Bacillus anthracis*, and in so far the results merely confirm what had already been discovered by Downes and Blunt in 1877 and 1878.[1]

From the fact that an apparent retardation of the development of the colonies on plates exposed to light was observed several times under circumstances which suggested a direct inhibitory action of even ordinary daylight, the author went further into this particular question with results as startling as they are important, for if the explanation given of the phenomena observed in the following experiments turns out to be the correct one, we stand face to face with the fact that by far the most potent factor in the purification of the air and rivers of bacteria is the sunlight. The fact that direct sunlight is efficacious as a bactericide has been long suspected, but put forward very vaguely in most cases.

Starting from the observation that a test-tube, or small flask containing a few c.c. of Thames water with many hundreds of thousands of anthrax spores in it may be entirely rid of living spores by continued exposure daily for a few days to the light of the sun, and that even a few weeks of bright summer daylight—not direct insolation—reduces the number of spores capable of development on gelatine, it seemed worth while to try the effect of direct insolation on plate-cultures to see if the results could be got more quickly and definitely.[2]

Preliminary trials with gelatine plate-cultures at the end of the summer soon showed that precautions of several kinds were necessary. The direct exposure of an ordinary plate-culture to the full light of even a September or October sun, especially in the afternoon, usually leads at once to the running and liquefaction of the gelatine, and although the exposed plates eventually showed fewer anthrax colonies than similar plates not exposed, the matter was too complicated to give satisfactory results. Obviously one objection was that the spores might have begun to germinate, and the young colonies killed by the high temperatures.

Experiments made in October with gelatine plates wrapped in black paper, in which a figure—a square, cross, or letter—was cut, also led to results too indefinite for satisfaction, although it was clear in some cases that if the plates lay quite flat, the illuminated area was on the whole clear of colonies, while that part of the plate covered by the paper was full of colonies.

But another source of vexation arose. After the plates had been exposed to the sunlight for, say, six hours, it was necessary to put them in the incubator (20°–22° C. was the temperature used) for two days or so, to develop the colonies, and in many cases it was observed that by the time the colonies were sufficiently

[1] See p. 237 of "First Report to the Water Research Committee of the Royal Society" ("Roy. Soc. Proc." col. 51, 1892) for the literature on this subject up to 1891.

[2] It appears that Buchner (*Centr. f. Bakt.* vol. xii. 1892) has already done this for typhoid, and finds the direct rays of the summer sun quite effective.

far advanced to show up clearly, liquefaction had extended so far as to render the figure blurred and doubtful.

Stencil plates of zinc were employed with, at first, equally uncertain results. The stencil plate was fixed to the bottom of the plate culture, outside, and every other part covered with blackened paper: the plate was then placed on a level surface, the stencil-covered face upward, and exposed to the direct sunlight. As before, the gelatine softened and in many cases ran, and the results were uncertain, though not altogether discouraging.

In November it was found that more definite results could be obtained, and the problem was at last solved.

Meanwhile it had already been found possible to obtain sun prints in the following way with agar plates. Ordinary agar was heated and allowed to cool to between 50° and 60° C., and was then richly infected with anthrax spores, and made into plates as usual. Such plates were then covered with a stencil plate on the lower face—the stencil plate being therefore separated from the infected agar only by the glass of the plate—and wrapped elsewhere closely in dull black paper, so that, on exposure to the sun only the cut-out figure or letter allowed the solar rays to reach the agar.

Such plates were then exposed to the direct rays of the October sun for from two to six hours; or they were placed on the

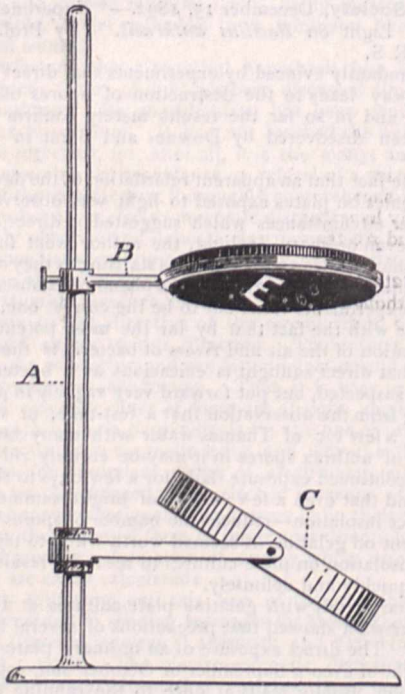

FIG. 1.

ring of a retort-stand, stencil downwards, and the sunlight reflected upwards from a plane mirror below.

After the insolation these plates were incubated for at least forty-eight hours at 20° C., and on removing the wrappers the colonies of anthrax were found densely covering all parts of the plate except the area—a letter or cross, &c.—exposed to the sunlight. There, however, the spores were killed, and the agar remained perfectly clear, showing the form of a sharp transparent letter, cross, &c., in a groundwork rendered cloudy and opaque by the innumerable colonies of anthrax.

Experiments proved that this was not due to high temperature, for a thermometer with its bulb next the insolated glass rarely rose beyond 14° to 16° C., and never beyond 18° C., and even if the thermometer did not record the temperature inside the plate, this can scarcely have been much higher.

As long as this latter point remained uncertain, however, the experiments could not be regarded as satisfactory; whence it was necessary to again have recourse to gelatine cultures. The gelatine employed began to run at 29° C., and in November it was found that such plates exposed outside, either to directly incident sunshine, or to directly reflected rays, showed a temperature of 12° to 13° C. at the insolated glass surface, and even five to six hours exposure caused no running of the gelatine.

The following experiment may be selected as a type of the rest:—A (Fig. 1) is the upright of an ordinary retort-stand; on the ring B rested a gelatine plate culture of anthrax spores, covered with black paper everywhere except the cut-out letter E, seen on its lower face. C was an ordinary plane microscope-mirror with its arm fitted to a cork on A.

The whole was placed in the middle of a field at 9.30 a.m. on Wednesday, November 30, and exposed to the clear, but low, sunshine which prevailed that day, the mirror being so arranged (from time to time as necessary) as to reflect the light on the E the whole period, until 3.30 p.m., when the plate was removed and placed in the dark incubator at 20° C. On the following Friday—*i.e.* after less than forty-eight hours' incubation—the letter E stood out sharp and clearly transparent from the faint grey of the rest of the plate of gelatine. Not a trace of anthrax could be found in the clear area, even with the microscope, while the grey and almost opaque appearance of the rest of the plate was due to innumerable colonies of that organism which had developed in the interval.

It was impossible to incubate the plate longer for fear of liquefaction, whence the sceptical may reply that the anthrax exposed to light was only retarded; the experiments with agar show that such is not the case, however, and that if the insolation is com-

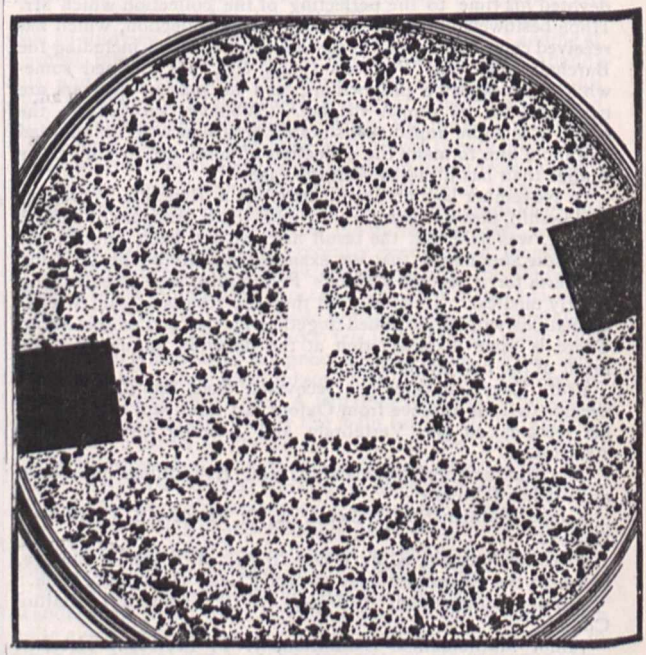

FIG. 2.

plete the spores are rendered incapable of germinating at all, as proved by removing pieces of the clear agar or gelatine and attempting to make tube cultures from them: in all cases where insolation is complete they remain sterile.

The chief value of these gelatine plate exposures in November, however, is that they prove conclusively (1) that the rays of a *winter* sun are capable, even if reflected, of killing the spores, and (2) that it is really the solar rays which do this directly, and not any effect of a higher temperature, since the gelatine remains solid throughout.

Experience has shown, however, that some precautions are necessary in selecting the anthrax cultures employed for these experiments with gelatine. The light certainly retards or kills (according to its intensity or the length of exposure) virulent spores, but if one takes the spores, mixed with vegetative bacilli, direct from a thoroughly liquefied gelatine culture, or from a bouillon culture, the plates are apt to be liquefied too rapidly for the proper development of the light print, evidently because so much of the liquefying enzyme is carried in when inoculating the plates. The same danger is run when active bacilli alone are employed.

The best method of avoiding these disadvantages has been

found to be the following, and it has the additional merit of enabling us to prove, beyond all doubt, that the ripe spores of *Bacillus anthracis* are really inhibited or killed by sunlight.

A few c.c. of sterile distilled water in a tube are thoroughly saturated with the anthrax spores taken from an old culture which has never been exposed to light, and the tube placed for twenty-four hours at 56° C.; this kills all immature spores, bacilli, and enzymes, and leaves us with a crop of the most resistant and fully matured virulent spores.

Experiments with such spores have been made to determine the relative power of the different rays of the spectrum to destroy the anthrax.

It is necessary to note first, however, that in experimenting with the electric light, although but few exposures have been made as yet, it is evident that its effects are feebler than those of the winter sun.

At present it has only been possible to observe that the inhibiting effects are stronger at the blue end of the spectrum than at the red, and exposures to sunlight passing through coloured glasses confirm this result; but the observations are being continued in the hope of getting a perfectly sharp record of the effects of each set of rays.

The following series of experiments are quoted in detail, because they teach several details of importance, in addition to proving the main fact.

On December 7 three gelatine plates and five agar plates were prepared with spores from a very vigorous and virulent agar tube of anthrax. The spores, which were quite mature, were not subjected to heat, but simply shaken in sterile water to wash and separate them thoroughly.

The three gelatine plates were made at 35° C., the agar plates at 60° C., neither of which temperatures could injure the ripe spores.

The three gelatine plates were labelled p 1, p 2, and p 3, and the agar plates p 4 to p 8 in order.

Immediately after making the plates, all were exposed to the December sun, except plates p 4, p 5, and p 6, and this was done as follows:—In each case the plate had a stencil plate with a cut-out letter on its lower face, and arranged as described above.

p 1, a gelatine plate with a *large* letter M, was exposed, face down, to the light reflected from a mirror (see Fig. 1) for three hours on December 7, and for four hours on December 8, the interval being passed in a cold room (t about 8°–9° C.), and then incubated at 20° in the dark.

p 8 was treated in exactly the same manner. But this was an agar plate with a *large* W.

p 2, a gelatine plate with a *large* H, was exposed and heated in the same way, except that no mirror was used, the latter being upwards towards the sun.

p 3, a gelatine plate with a *large* B, was similarly exposed, face up, but a plane mirror arranged to reflect light down upon it.

p 7, an agar plate with a *large* E, was treated exactly as the last.

There now remain the three agar plates, p 4, p 5, and p 6, to account for.

p 4 was placed forthwith in the dark incubator at 20° C.

p 5 and p 6 were kept for eighteen hours in a drawer, the average temperature of which is almost 16° C., and were not exposed till next day (December 8), when they lay for five hours, face upwards, and with a mirror above them. p 5 had a *small* E, and p 6 a broad but small I to let the light in.

After exposure, these also were put in the same incubator with the others.

Nothing was visible to the unaided eye on these plates (except p 4) until the 11th instant, though the microscope showed that germination was proceeding on the 10th. The plate p 4, however, had a distinct veil of colonies all over it on the 9th, and this had developed to a dense typical growth by the 11th.

On December 11, at 10 a.m., the state of affairs, as regards the exposed plates, was as follows:—

p 5 and p 6 showed each a sharp transparent letter—E and I respectively—of clear agar in a dull grey matrix of strong anthrax colonies, which covered all the unexposed parts of the plate.

p 1, p 2, and p 3 showed in each case a perfectly clear central patch, about 1½ inches diameter, with anthrax colonies in the gelatine around. These anthrax colonies were the *larger and more vigorous the more distant they were from the clear centre.* In other words, the anthrax spores had begun to germinate, and the colonies were growing more vigorously, in centripetal order.

On p 7 and p 8 germination was beginning, but the colonies were as yet too young to enable one to judge of the results.

The first point of interest is to account for the pronounced results in the plates p 5 and p 6, and the want of sharp outlines in p 1, p 2, and p 3, and the explanation seems to be that, owing to the plates 5 and 6 having laid over night at 16° C., the spores began slowly to germinate out, *and were consequently in their most tender condition* when exposed to the sunlight next day.

The peculiar centripetal order of development of the colonies on plates p 1, p 2, and p 3 gave rise to the following attempt at explanation. After observing that the clear space in the middle was not due to the centre of the plate being raised, and the infected gelatine having run down to the periphery—a possible event with some batches of Petrie's dishes—it was surmised that the *large* letters employed might give the clue.

This was found to be the case. The solar rays on entering the plate were largely reflected from the glass lid of the plates, and so produced feebler insolation effects on parts of the plate around the letter; these effects were naturally feebler and feebler towards the margin, and so the inhibitory action became less pronounced at distances further and further removed from the centre. Those spores, therefore, which were nearest the periphery germinated out first, and those nearer the centre were retarded and more and more in proportion to their proximity to the insolated letter.

That this is the correct interpretation of the facts follows clearly from the further behaviour of the above plates.

At 10 p.m. on the 11th—*i.e.* twelve hours after the morning examination—the plates p 1, p 2, and p 3 exhibited their respective letters M, H, and B quite clearly, in the grey matrix of anthrax which had rapidly developed in the interval, and excepting a slight want of sharpness in the H of p 2, the results could hardly have been more satisfactory.

In p 7 and p 8 the *very faint* outlines of the letters were also showing.

On the 12th, at 8.30 a.m., the gelatine plates had begun to run, and although the M of p 1 was still intact, and very well marked, p 2 had liquefied completely, so that the H was a clear patch with blurred outlines in the centre. p 3 still showed the outlines of the B, but it was impossible to keep it longer.

The main point was definitely established, however, and the treatment of the plates proves conclusively that the spores are not killed by high or low temperatures, *but by the direct solar rays.*

These experiments are being continued in order to answer some other questions in this connection.

The gelatine and agar after such exposures as have been described are still capable of supporting a growth of *B. anthracis* if fresh spores are sown on them, whence the effects described are not merely due to the sub-strata being spoilt as food material.

Royal Meteorological Society, January 18.—Dr. C. Theodore Williams, President, in the chair.—After the report had been read, and the officers and council for the ensuing year had been elected, the President delivered an address on the high altitudes of Colorado and their climates, which was illustrated by a number of lantern slides.—Dr. Williams first noticed the geography of the plateaux of these regions, culminating step by step in the heights of the rocky mountains, and described the lofty peaks, the great parks, the rugged and grand cañons, and the rolling prairie, dividing them into four classes of elevations between 5000 and 14,500 feet above sea level. He then dwelt on the meteorology of each of these divisions; giving the rainfall and relative humidity, and accounting for its very small percentage by the moisture being condensed on the mountain ranges of the Sierras lying to the west of the Rockies; also noticing the amount of sunshine and of cloudless weather, the maxima and minima temperatures, the wind force, and the barometric pressure. Dr. Williams quoted some striking examples of electrical phenomena witnessed on Pike's Peak (14,147 feet) by the observer of the U.S. Weather Bureau, when during a violent thunderstorm flashes of fire and loud reports, with heavy showers of sleet, surrounded the summit in all directions, and brilliant jets of flame of a rose-white colour jumped from point to point on the electric wire, while the cups of the anemometer, which were revolving rapidly, appeared as one solid ring of fire, from which issued a loud rushing and hissing sound. During another storm the

observer was lifted off his feet by the electric fluid, while the wristband of his woollen shirt, as soon as it became damp, formed a fiery ring around his arm. The climate of the Parks is, however, Dr. Williams considered, of more practical interest, and in these magnificent basins of park-like country interspersed with pines, and backed by gigantic mountains, are resorts replete with interest for the artist, the sportsman, the man of science, and the seeker for health. Most of them lie at heights of from 7000 to 9000 feet, and so good is the shelter that usually snow does not long remain on the ground, while Herefordshire cattle in excellent condition are able to fatten on the good herbage, and to lie out all the winter without shed or stable. Dr. Williams predicted for these parks a great future as high altitude sanitaria for the American continent, especially as several of them have been brought within easy distance of Denver, the queen city of the plains, by various lines of railway. The resorts on the foothills and on the prairie plains, at elevations of 5000 to 7000 feet, include, besides Denver, Colorado Springs, Manitou, Boulder, Golden, and other health stations, which can be inhabited all the year round, and where most of the comforts and luxuries of American civilisation are attainable in a climate where not more than half a day a week in winter is clouded over, where the rainfall is only about 14 inches annually, most of which falls during summer thunderstorms, where the sun shines brightly for 330 days each year, and where the air is so transparent that objects twenty miles off appear close at hand, and high peaks are calculated to be visible at a distance of 120 miles. Dr. Williams summed up thus:—The chief features of the climate of Colorado appear to be (1) Diminished barometric pressure, owing to altitude, which, throughout the greater part of the State, does not fall below 5000 feet. (2) Great atmospheric dryness, especially in winter and autumn, as shown by the small rainfall and low percentage of relative humidity. (3) Clearness of atmosphere and absence of fog or cloud. (4) Abundant sunshine all the year round, but especially in winter and autumn. (5) Marked diathermancy of atmosphere, producing an increase in the difference of sun and shade temperatures, varying with the elevation in the proportion of 1° for every rise of 235 feet. (6) Considerable air movement, even in the middle of summer, which promotes evaporation and tempers the solar heat. (7) The presence of a large amount of atmospheric electricity. Thus the climate of this state is dry and sunny, with bracing and energising qualities, permitting outdoor exercise all the year round, the favourable results of which may be seen in the large number of former consumptives whom it has rescued from the life of invalidism and converted into healthy active workers; and its stimulating and exhilarating influence may also be traced in the wonderful enterprise and unceasing labour which the Colorado people have shown in developing the riches, agricultural and mineral, of their country.

Entomological Society, January 18.—Sixtieth Annual Meeting.—Mr. Frederick DuCane Godman, F.R.S., President, in the chair.—An abstract of the treasurer's accounts having been read by Mr. J. Jenner Weir, one of the auditors, the secretary, Mr. H. Goss, read the report of the Council. After the ballot it was announced that the following gentlemen had been elected as officers and Council for 1893:—President, Mr. Henry J. Elwes; Treasurer, Mr. R. McLachlan, F.R.S.; Secretaries, Mr. Herbert Goss and the Rev. Canon Fowler; Librarian, Mr. George C. Champion; and as other members of the Council, Mr. C. G. Barrett, Mr. Charles J. Gahan, Mr. F. DuCane Godman, F.R.S., Mr. Frederic Merrifield, Mr. Osbert Salvin, F.R.S., Dr. David Sharp, F.R.S., Colonel Charles Swinhoe, and Mr. George H. Verrall. The President then delivered an address which, though containing reference to the Society's internal affairs and an allusion to the successful resistance made by naturalists and others to the War Office scheme for establishing a rifle-range in the New Forest, consisted for the most part of full obituary notices of Fellows of the Society who had died during the year, special mention being made of Mr. Henry W. Bates, F.R.S., Prof. Hermann C. C. Burmeister, Dr. Carl A. Döhrn, Mr. H. Berkeley-James, Mr. J. T. Harris, Sir Richard Owen, K.C.B., F.R.S., Mr. Henry T. Stainton, F.R.S., Mr. Howard Vaughan, and Prof. J. O. Westwood, the Hon. Life President. Votes of thanks to the President and other officers of the Society having been proposed by Lord Walsingham, F.R.S., and Dr. D. Sharp, F.R.S., and seconded by Mr. J. H. Leech and Mr. W. H. B. Fletcher, Mr. Godman, Mr. McLachlan, Mr. H. Goss, and Canon Fowler severally replied, and the proceedings terminated.

Linnean Society, January 19.—General Meeting, Prof. Charles Stewart, President, in the chair.—After the confirmation of the minutes the President referred in suitable terms to the losses sustained by biologic science in the deaths of Sir Richard Owen and Prof. J. O. Westwood, who had been Fellows of the Society for 56 and 64 years respectively.—Mr. George Brook showed photographs of corals which he had lately taken and had reproduced by permanent process at a cost below lithography, with the added advantage of permitting amplification by a hand lens.—The President read a paper on the auditory organ of the angel fish (*Rhina squatina*).—Mr. W. Carruthers, F.R.S., V.P.L.S., then laid before the Society the results of a collection made by Mr. Alexander Whyte in the Malanji country, in the Shiré highlands, in October, 1891, and the plants were determined by the officers of the Botanical Department, British Museum, about sixty, or, roughly speaking, one-fifth, proving new to science. Whilst Sir J. D. Hooker defined the flora of Kilimanjaro as Abyssinian in character, the Malanji flora displays a much closer relationship to the Cape.—The last paper was by Mr. G. F. Scott Elliot, and was his report as botanist to the Anglo-French Sierra Leone Boundary Commission, in which he gave an account of the economic aspects of the districts traversed.

Geological Society, January 11.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Variolite of the Lleyn, and associated volcanic rocks, by Catherine A. Raisin, B.Sc. Communicated by Prof. T. G. Bonney, F.R.S. The district in which these rocks occur is the south-western part of the Lleyn peninsula, marked on the Geological Survey map as "metamorphosed Cambrian." Some of the holocrystalline rocks are probably later intrusions. The igneous rocks, which are described in detail in the present paper, belong to the class of rather basic andesites or not very basic basalts; they show two extreme types, which were probably formed by differentiation from an originally homogeneous magma. Corresponding to the two types of rock are two forms of variolite. These are fully described, and their mode of development is discussed. The variolites occur near Aberdaron, and at places along the coast. Their spherulitic structure often is developed towards the exterior of contraction-spheriods, and in this and in other particulars they correspond with those of the Fichtelgebirge and of the Durance. The volcanic rocks include lava-flows and fragmental masses, both fine ash and coarse agglomerate. They are associated with limestones, quartzose, and other rocks, which are possibly sedimentary, but which give no trustworthy evidence of the age of the variolites. Prof. Judd complimented the authoress on the evidently great amount of labour and patient research devoted to this investigation. He thought the occurrence of the spherulitic structure round the surfaces of "pillow-like masses," similar to those described by Prof. Dana, was exceedingly interesting, especially when one considered the probably very great antiquity of these Caernarvonshire rocks. He thought, also, the suggestion that early crystallised magnetite-grains had formed the nuclei of the spherulites, was a very interesting and probable one. Mr. Alfred Harker, Profs. Bonney, Hull, and J. F. Blake also spoke.—On the petrography of the island of Capraja, by Hamilton Emmons. Communicated by Sir Archibald Geikie, For. Sec. R.S. The rocks of Capraja consist generally of andesitic outflows resting on andesitic breccias and conglomerates. The southern end seems to have formed a distinct centre of volcanic activity, whose products are younger in age and more basic in character than the rocks of the rest of the island, and may be termed "anamesites." The lavas appear to have flowed from a vent at some distance from the cone, which probably occurred here, and gave out highly scoriaceous fragments. In the other parts of the island andesite is almost everywhere formed, with patches of the underlying breccias here and there in the valley bottoms. The chief centre of activity probably lay west of the centre of the island. Petrographical details of the andesites and anamesites, descriptions of the groundmass and included minerals of each, and chemical analyses are given. As regards the age of the constituents, the author arranges them in the following order, commencing with the oldest:—Magnetite, olivine, augite, mica, felspar, nepheline. After the reading of this paper Dr. Du Riche Preller gave an outline of the leading geological and the

analogous petrological features of the several islands of the Tuscan Archipelago, of Corsica, Sardinia, the Carrara mountains, and the Maremma hills. The President also spoke.

Zoological Society, January 17.—Sir W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the society's menagerie during the month of December, 1892.—Mr. F. C. Selous exhibited and made remarks on the head of a hybrid antelope between the Sassaby (*Bubalis lunata*) and Hartebeest (*B. caama*); also a head of a female Koodoo (*Strepsiceros kudu*) with horns, and heads of some other South African antelopes.—Mr. O. Thomas exhibited some examples (from the Baram River, Sarawak, collected by Mr. Hose) of the monkey that he had lately described as *Semnopithecus cruciger*, and stated that, in spite of the confirmation afforded by these specimens, Mr. Hose thought that this species might possibly be only an erythrism of *S. chrysomelas*.—A communication was read from Mr. E. Y. Watson, entitled, "A proposed classification of the *Hesperiidæ*, with a revision of the Genera." This contained a preliminary classification of the *Hesperiidæ*, including the numerous modern genera, which were arranged under three subfamilies according to the sexual differences, the resting posture, the antennæ, the spurs on the hind tibiæ, and the position of vein 5 (relative to veins 4 and 6) of the fore wing. The subfamilies were named Pyrrhopyginæ, Hesperiinæ, and Pamphilinæ, and the two last were subdivided into sections without names. In all 234 generic names were dealt with, of which 49 were treated as synonyms, while 45 new genera were described. Complete diagnoses were given of all the admitted genera.—A communication was read by Mr. E. E. Austen, entitled "Descriptions of New Species of Dipterous Insects of the Family *Syrphidæ*, in the Collection of the British Museum, with Notes on Species described by the late Francis Walker." This communication contained descriptions of twenty-three new species belonging to the division *Bacchini*, and of one belonging to the *Brachyopini* (genus *Rhingia*). An attempt was made to divide the genus *Baccha*, as at present existing, into three groups, based chiefly upon the shape and markings of the abdomen. The true position of the remarkable genus *Lycastrirhyncha*, founded by Bigot on a species from Brazil, and afterwards cancelled by its author in favour of *Rhingia*, was established. It was shown that this genus had nothing to do with *Rhingia*, but was one of the *Eristalini*, closely allied to *Eristalis*. It was also shown that the genus *Lycastris*, founded by Walker for a species from India, was not identical with *Rhingia* (as had been likewise suggested by Bigot), but belonged to the *Xylotini*, and was allied to *Criorrhina*. A communication was read from Mr. Gilbert C. Bourne, containing descriptions of two new species of Copepodous Crustaceans from Zanzibar, proposed to be called *Canthocamptus finni* and *Cyclops africanus*.—Mr. Sclater exhibited and made remarks on the typical specimen of a rare Argentine bird (*Xenopsaris albinucha*) described by the late Dr. Burmeister in 1868.

Anthropological Institute, January 24.—Anniversary meeting.—Dr. Edward B. Tylor, F.R.S., in the chair.—The following were elected officers and council for the ensuing year:—President, Prof. A. Macalister. Vice-Presidents, J. G. Garson, Chas. H. Read, F. W. Rudler. Secretary, C. Peek. Treasurer, A. L. Lewis. Council: G. M. Atkinson, Henry Balfour, E. W. Brabrooke, Hyde Clarke, J. F. Collingwood, Prof. D. J. Cunningham, W. L. Distant, J. Edge Partington, A. J. Evans, H. Gosselan, Prof. A. C. Haddon, T. V. Holmes, R. Biddulph Martin, R. Munro, F. G. H. Price, Oldfield Thomas, Arthur Thomson, Coutts Trotter, M. J. Walhouse, Gen. Sir C. P. Beauchamp Walker.

EDINBURGH.

Royal Society, January 16.—Prof. Copeland, Vice-President, in the chair.—A paper, by Dr. W. Pole, on the present state of knowledge and opinion in regard to colour blindness, was communicated. He discussed alone the red-green form of colour blindness. In such a case the solar spectrum presents only two hues separated by a nearly colourless portion—a mixture of blue and yellow lights giving rise to a gray colour. According to Young the three primary colour sensations correspond to red, green, and blue or violet, and Maxwell and Helmholtz, reasoning on this theory, conclude that the colours seen in dichromic vision are green and blue. According to Dr. Pole, they are yellow and blue. He asserts that comparisons between normal and abnormal visions show that in general matches of colours made by a normal eye are also matches when regarded by a dichromic eye. He concludes that the two dichromic colours are colours known in normal vision. He then gives reasons for the conclusion that these colours are normal blue and yellow. In answer to the suggestion that the real subjective impressions may differ from what they are supposed to be, he says that the correspondence is proved by a large amount of evidence obtained by comparison with normal phenomena. He thinks that the following conclusions may be drawn from the second edition of Helmholtz's work on optics:—(1) The original mode of explanation of colour blindness by Young's theory is essentially withdrawn as no longer consistent with modern knowledge. The universal concurrent testimony, that the ordinary colour dichromic vision generally corresponds with is normal yellow and blue and white, is no longer disputed, and although there are variations of sensations in regard to red and green, the old ideas of blindness to red and green as separate and contrasting defects are abandoned; (2) that Young's general theory of three fundamental colour-sensations is still adhered to, but that the colours are now believed to differ considerably in the spectrum; (3) that dichromic vision might exist consistently with the retention of three fundamentals; (4) that the most prevalent form of dichromatism might be explained by the junction of the red and green fundamentals forming yellow. In conclusion, he regretted that the colour-vision committee of the Royal Society, in a recent chart dealing with colour blindness, had adhered to the old view held by Clerk Maxwell. Sir George Stokes remarked that the fundamental part of Young's original theory was that there were three colour sensations; and though he supposed them to be red, green, and violet, that was not essential. Maxwell only chose red, green, and blue, as representative sensations. He was doubtful of the wisdom of publishing the charts alluded to lest it might lead to misconception. The object of publishing them was to give to the public a general idea of the conclusions derivable from the trichromic theory.

SYDNEY.

Royal Society of New South Wales, December 7, 1892.—Prof. Warren, President, in the chair.—The Chairman announced that the Clarke Medal for 1893 had been awarded by the Council to Prof. Ralph Tate, of the Adelaide University.—A letter was read from the Hon. Ralph Abercromby, enclosing a cheque for £100, which he desired to place in the hands of the Council of the Society with the object of bringing about an exhaustive study of certain features of the Australian weather, the particulars to be furnished in a later letter. The following papers were read:—Observations on shell heaps and shell beds, the significance and importance of the record they afford, by E. J. Statham.—A new mineral from Broken Hill, by C. W. Marsh (communicated by Prof. Liversidge).—Notes on some Australian stone weapons, by Prof. Liversidge, F.R.S.—Notes on the recent cholera epidemic in Germany, by Dr. Schwarzbach.—Results of observations of Wolf's comet II., 1891, Swift's comet I., 1892, and Winnecke's periodical comet, 1892, at Windsor, New South Wales, by John Tebbutt.—On the comet in the constellation Andromeda, by John Tebbutt.—Languages of Oceania, by Dr. John Fraser.

August 17.—*Engineering Section*.—C. W. Darley in the chair.—Papers read:—Various systems of tramway traction, by W. F. How.——November 16.—Some notes on the economical use of steam, by T. H. Houghton.—Recent bridge building in New Zealand, by A. Alabaster.

PARIS.

Academy of Sciences, January 23.—M. Lœwy in the chair.—Note on Nicolas de Kokcharow, by M. Daubrée.—Contributions to the study of the function of camphoric acid, by M. A. Haller.—On the pepto-saccharifiant action of the blood and the organs, by M. R. Lépine. If blood is poured into several parts of water at 56° C. a considerable quantity of sugar is formed in a few seconds, and the formation goes on for about an hour with decreasing rapidity. In cold or lukewarm water sugar is also produced, but its production is for the most part compensated by simultaneous glycolysis. It is also probable that the production of sugar is preceded by that of peptone. If an organ which does not enclose glycogen in any perceptible quantity be macerated for about an hour in three or four parts of water, the aqueous extract only contains a very small quantity

of substances capable of reducing Fehling's solution, and hardly any sugar. If to this aqueous extract be added a small quantity of peptone, and the whole be kept at 56°C. during an hour, a certain quantity of sugar is formed, as proved by fermentation and the phenylhydrazine test. Hence the aqueous or glycerine extract contains a ferment which may be termed pepto-saccharifiant. It is probable that the formation of sugar is not confined to the liver, as ordinarily supposed, but that several organs play a part in it.—Observations of the planet Charlois T (December 11, 1892), made at the Toulouse Observatory, by M. B. Baillaud.—Contribution to the investigation of the solar corona apart from total eclipses, by M. H. Deslandres (see Astronomical Column).—Observations of the sun made at the Lyon Observatory (Brunner equatorial) during the latter half of 1892, by M. Guillaume.—On the limitation of degree for the general algebraic integral of the differential equation of the first order, by M. Autonne.—On Van der Waals's equation and the demonstration of the theorem of the corresponding states, by M. G. Meslin.—Magnetic properties of bodies at different temperatures, by M. P. Curie.—The magnetic permeabilities of a series of diamagnetic bodies, including, amongst others, bismuth, antimony, phosphorus, sulphur, and some potassium salts, were determined by enclosing them in an exhausted glass vessel exposed to a magnetic field, and subsequently repeating the experiment with the glass alone. Most of the substances showed a remarkably constant coefficient. Water and quartz did not show a perceptible variation with temperature, and potassium nitrate had the same coefficient when solid and when fused. That of bismuth, on the other hand, fell steadily up to the point of fusion, and then (at 273° C.) abruptly from 0·957 to 0·038, after which it remained constant. Electrolytic antimony had a much feebler coefficient than the ordinary variety.—Contribution to the study of equalisers of potential acting by flow, by M. G. Gouré de Villemontée.—Luminous phenomena observed at the Lyon Observatory on the evening of January 6, 1893, by M. Gonnessiat.—A method for measuring objectively the spherical aberration of the living eye, by M. C. J. A. Leroy.—On the atomic weight of palladium, by MM. A. Joly and E. Leidié.—Action of the alkaline alcoholates on camphoric and other anhydrides, by M. P. Cazeneuve.—Modification of arterial pressure under the influence of pyocyanic poisons, by MM. Charrin and Teissier.—On some cases of infectious arthrodentary gingivitis observed in animals, by M. V. Galippe.—Primary bedding of platinum in the Ural, by M. A. Inostranzeff. The native platinum occurs embedded in a rocky matrix consisting of the variety of peridotite known as dunite. It is found in Mount Solovieff, which consists of alternate layers of chrome-iron and serpentine.—On the existence of overfolds in the Blida Atlas (Algeria), by M. E. Ficheur.

BERLIN.

Physical Society, January 6.—Prof. du Bois Reymond, President, in the chair.—Prof. Raoul Pictet gave an account of experiments made by Messrs. Sarasin and De la Rive by which the rate of the electric waves discovered by Hertz had been measured, and their identity with waves of light in the ether determined. By using large metallic surfaces sixteen metres in diameter as reflectors, and by allowing the discharge of the primary spark to take place under oil instead of in the air, it was found possible to obtain stationary electric waves in a long gallery and to determine their nodal points. In the discussion which ensued Prof. Kundt stated that Dr. Zenker was the first person who had explained the photographing of colours by means of stationary waves; that stationary light-waves were first experimentally determined by Dr. Wiener, and that Seebeck was the first to take photographs of coloured objects. After Prof. H. W. Vogel, pictures due to the action of light were first taken by a doctor named Schulz, in Halle. In 1727 this observer treated a solution of nitrate of silver in a small box with calcium chloride and obtained a greyish precipitate. He then covered the box with a lid in which was a hole the shape of some letter, and on subsequently examining the precipitate he saw a dark image of the letter on it. The experiment was found to fail in the dark. Schulz hence concluded that the image of the letter was due to the action of light.

Meteorological Society, January 10.—Prof. Schwalbe, President, in the chair.—Dr. Kremser spoke on the imperfection of the means available for the study of atmospheric currents, which, even in the most elevated stations, are profoundly modified by the topography of the neighbourhood. The direction and rate of these currents can only be ascertained by observing the motion of a small pilot-balloon of some one cubic metre capacity, a specially constructed theodolite being used for this purpose.—Prof. Hellmann exhibited a series of photographs of snow-crystals taken by Dr. Neuhauss, together with the oldest existing figures of these crystals, due to Olaus Magnus in 1455. The chief points of interest shown by these photographs were the not infrequent asymmetry of the crystals and the occurrence on them of small ice-lumps.

Physiological Society, January 13.—Prof. du Bois Reymond, President, in the chair. Dr. Behring gave an account of the present state of affairs as regards what may be called the blood-serum therapeutists, illustrating his remarks by experiments he had made with serum from an immune horse on mice inoculated with tetanus-bacilli. A number of mice were inoculated with more or less strong doses of the bacilli. Those which had previously been treated with the horse-serum did not die, and in many cases where the serum was injected after the inoculation death did not ensue. Observations on man are in progress, and will be published as soon as sufficient data are to hand on the treatment of tetanus and diphtheria by the use of serum from immune animals.—Dr. Hahn, of St. Petersburg, gave an account of experiments made in conjunction with Profs. Pawlow and Nencki on the action of an Eck's fistula, and the conducting of blood from the portal vein directly into the inferior vena cava. Among the various results of the operation he stated that the output of urea was lessened and that of uric acid increased, a result which the experimenters attributed to a cessation in the conversion of carbamic acid into urea due to exclusion of the liver. They further found that carbamic acid produced symptoms similar to those exhibited by the animals on which they had operated.—Prof. Kossel and Dr. Raps exhibited an automatic mercurial pump for blood-gas analysis.

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