THURSDAY, MARCH 14, 1901.

A MANUAL OF MEDICINE.

A Manual of Medicine. Edited by W. H. Allchin, M.D., F.R.C.P., F.R.S. Edin. Vol. i. Pp. viii + 442. Plates 2; and Vol. ii. Pp. viii + 380. Plates 2. (London: Macmillan and Co., Ltd., 1900.) 7*s.* 6*d.* net each.

THE work before us is to consist of five volumes, and will thus eventually cover some 2000 pages; the term manual, therefore, by which it is designated, applies rather to each individual volume than to the whole work. It is essentially a system of medicine. It can be seen at a glance that the book is of an essentially different type from Allbutt's system, recently completed. It deals much more succinctly with the respective subjects, and contains no bibliographies. We assume from this—there is no preface—that the work is intended not so much for a book of reference as a text-book for students, and as a handy reference book for practitioners. In the space at our disposal it is impossible to consider at all fully the two volumes before us, and nothing remains but to take a few of the most important monographs as types.

Vol. i. begins with an introduction by the editor, in which he discusses the bases of our conception of disease and the classification of diseases. He concludes by adopting the orthodox classification, viz. local, or diseases of individual organs, and general, or those diseases in which the entire body is concerned and no preponderance of symptoms in one region occurs. It is with this latter class of diseases that both the volumes before us are concerned. The general diseases are again divided into those of extrinsic and intrinsic origin; the former including abnormal states caused by atmospheric influences, parasites, vegetable and animal, and poisons introduced into the body as such; the latter comprising primary perversions of general nutrition and diseases of the blood.

The infections are treated by Dr. Sims Woodhead. The article includes the bacteriology of the subject, in so far as its essentials are concerned, and bacteriological chemistry, a consideration of toxins, anti-toxins, immunity and, finally, a classification of the infective diseases met with in man, arranged according to their cause. The same author writes upon sapræmia, septicæmia and pyæmia. Dr. Hale White communicates a succinct article upon fever. He discusses the factors at work in the production of fever which differ from the physiological standpoint, and enters at some length into the parts played by increase of heat production and diminution of heat loss. According to him fever cannot, from the standpoint of its physiological cause, be regarded as an entity, the method of its production varying with the cause. The author concludes by indicating the methods which should be employed to reduce fever. Dr. Cayley contributes a full clinical monograph upon typhoid fever. The article is very carefully written, and, considering the space it covers (twenty odd pages), is very complete. It is interesting to note that the author considers "the evidence for the preventive action of the typhoid vaccine much stronger than that for the curative action of the serum," and recommends its trial "during epidemics and in persons, like nurses, who are especially exposed to infection."

Plague and cholera are dealt with by Dr. Cantlie. The author gives the results of Hafkine's inoculations in both these diseases. The articles upon dysentery, leprosy, malaria and several other tropical diseases are also written by Dr. Cantlie. The chapter on diphtheria is by Dr. Foord Caiger, and includes a most instructive table compiled from the total admissions into the Metropolitan Asylums Board hospitals of patients suffering from this disease. The table deals with a total of 25,000 cases, the ages of which vary from one year to sixty, and shows that while the average mortality of the whole is 24·7 per cent., the mortality in children between one and two years old is 50·2 per cent. The satisfactory results of the treatment of diphtheria by anti-toxic serum are evidenced by the dictum of the author "that a dose of from 2000 to 8000 units of anti-toxin should be given at the earliest moment in every case when the patient is a child." The articles on Rötheln, measles, scarlet fever and chicken-pox are from the pen of the same author.

Dr. Monckton Copeman supplies two monographs, upon small-pox and vaccinia respectively. In the article on small-pox reference is made to the work of Mr. Power concerning small-pox hospitals acting as a source of infection through the small-pox contagion being carried from them for a certain distance through the air. The importance of this fact cannot be over-estimated, and it is to be hoped that definite results, quantitative with regard to distance, will be obtained in this regard for other infectious diseases. The article on vaccinia includes extracts from the *Report* of the Royal Commission on Vaccination (1898), and also a consideration of the technique of vaccination.

In vol. ii. general diseases are continued. Dr. T. W. Shaw and Dr. James Cantlie contribute articles upon the diseases caused by parasites. Dr. Poore, conjointly with the editor, writes upon diseases determined by poisons introduced into the body as such—alcohol, morphine, cocaine, phosphorus and the ordinary metallic poisons being dealt with. Dr. Lazarus-Barlow contributes a general article upon inflammation and its sequels, and the editor one upon malignant disease. The possible parasitic origin of malignant growths is discussed shortly but adequately, and the references to the chief of the many exhaustive monographs upon this subject are given, a method, it may be noted in passing, which might have been advantageously adopted more frequently throughout the book. A short but interesting essay upon rickets is contributed by Dr. Coutts. The ætiology of this disease is only very shortly discussed; but it is instructive to note that the author directly contradicts the assertion that rickets never occurs in children fed entirely on mothers' milk. It is of the greatest possible importance to the public health to be quite clear upon this subject; the universality of rickets and the profound extent to which it affects the subsequent growth and activity of the various organs of the body is probably unsurpassed by any other morbific agency. Two articles upon diabetes mellitus and insipidus, respectively, are written by Dr. Bertrand Dawson. The article on gout is by Dr. Luff. In writing a short article presumably for students one

must obviously be didactic. This method, however, has its limits; in this case we think these limits have been somewhat exceeded. The student, or even the practitioner, who does not supplement the knowledge of gout he has obtained from this source by some further reading will not, we are afraid, be in possession of the whole truth concerning this disease.

The remainder of the book is devoted to the diseases of the blood, the section being introduced by a chapter upon the blood under normal conditions, by Dr. Louis Jenner. This chapter will be found exceedingly useful to those interested in this subject; it is concise and up-to-date, and deals with the more generally employed technique. The diseases of the blood themselves are dealt with by Dr. Sidney Coupland.

In the case of the work before us, the reviewer finds himself in rather an anomalous position in that the editor has written no preface, so that it is difficult to know by what standard the book should be judged. From a careful perusal of it we should place it mid-way between a book of reference and an ordinary text-book of medicine. Had it contained fuller references to the literature it might almost have ranked as a reference-book; as it is, it will no doubt fill a very useful place, which it thoroughly deserves to do, in the library of the advanced medical student and the practitioner.

A NEW CLASSIFICATION OF THE REPTILES.

Beitrag zur Systematik und Genealogie der Reptilien. By Prof. Max Fürbringer. Pp. 91. (Jena: Fischer, 1900.) Price Mk. 2.50.

IN the year 1873 Prof. Fürbringer, who has quite recently succeeded his illustrious master in the chair of comparative anatomy at Heidelberg, commenced to publish a series of contributions to the morphology of the pectoral girdle of reptiles, with special reference to the myology, the fourth and concluding part of which has now appeared. This highly elaborate piece of work is supplemented by a chapter entitled "Beitrag zur Systematik und Genealogie der Reptilien," in which the author sets forth his views on the phylogenetic arrangement of the class Reptilia.

As regards the origin of reptiles, the numerous fossil remains with which we are already acquainted seem to indicate so complete a passage from the Stegocephalous Batrachians, that the question at issue has lately been where to draw the dividing line between the two classes, an uncertainty which is further emphasised by the fact that the Microsauria, such as *Hylonomus* and *Petrobates*, of Carboniferous age, placed by most authorities among the Stegocephala, are included in the Reptilia by Prof. Fürbringer. From a knowledge of these connecting forms the conclusion must, it seems, follow that the ancestors of the Reptilia proper, themselves probably derived from Crossopterygian Fishes, as believed by Cope, Baur, and many other modern zoologists, possessed a skull with numerous membrane bones roofing over the temporal and occipital regions and with an immovable quadrate, that they belonged, in fact, to the type designated by Cope as monimostylic. In the process of evolution, in the series known as the Squamata (lizards and snakes), the predominant modern reptilian type, the number of membrane bones having been reduced and the temple left more and more unprotected, the quadrate became free and more or less movably articulated to the squamosal and supratemporal (streptostylic skull of Cope). The direction of the line of evolution in this instance, running as it does concurrently with the reduction and disappearance of the limbs, seems clear enough, and it is further supported by geological data, all early Reptiles and Batrachians being monimostylic without a known exception, whilst the streptostylic types appear first in the Jurassic as Lacertilia, to be followed by Snakes in the Eocene.

These conclusions are, however, set aside by Prof. Fürbringer. For him, the streptostylic condition is the primitive one, and, from the partial homology which he believes to have established between the spheno-pterygo-quadrate muscle of the Lacertilia and the *tensor veli maxillae superioris* of Selachians, he is led to look upon the condition exhibited by Geckos and Monitors as nearer the original one than that known in *Sphenodon*, in which the said muscle is much reduced. From this sole consideration, and by the purely gratuitous assumption that some early Rhynchocephalians, such as *Kadaliosaurus*, and Microsaurians may eventually prove to have been streptostylic, the author thinks himself justified in holding that the ancestral types from which the Lacertilians have been derived cannot be sought for among either the Stegocephalians or the Rhynchocephalians with the cranial structure of which we are at present acquainted, but that they will be found to be connected with some primitive hypothetical Amphibian type in which the quadrate was movably articulated with the skull, as in the lowest form of living Selachians.

"That such primitive streptostylic Amphibians have once existed, is rendered probable by the facts ascertained in the ontogeny of the living Amphibians. Probably streptostyly became converted into monimostyly as, in the course of evolution, their originally superficial apparatus of dermal bones became more and more intimately connected with the quadrate, the mobility of which consequently lessened and finally completely ceased."

This reasoning, by which, on the ground of the imperfections of the geological record, chronological indications are absolutely ignored, is not likely to meet with general favour. After the multitude of well-preserved Carboniferous and Permian "Eotetrapoda" which have lately been discovered and described by Credner, Fritsch and others, it will be difficult to accept the author's teaching that we know practically nothing of the progenitors of existing reptiles, and that these must be connected through a series of hypothetical Proamphibia or Protetrapoda with equally hypothetical Selachian-like animals.

As a consequence of the above assumption, the new classification differs fundamentally from those hitherto based on phylogenetic considerations, in this, that the Streptostylia s. Squamata, with the two orders Lacertilia and Ophidia, are placed at the base of the series. The Rhynchocephalia, Acrosauria, Microsauria and Ichthyopterygia are associated with them in a subclass Tocosauria. A second subclass, Theromorpha s. Theromora, includes the Dicynodonts, Anomodonts and Pariasaurians; a third, Synaptosauria, the Mesosaurians, Sauropterygians

and Chelonians; whilst in a fourth, Archosauria, the Crocodilians, Dinosaurs and Pterodactyles are brought together. Little objection will be found to the composition of the second and fourth subclasses, as it answers to the views held by almost all modern classificators. But it is difficult to believe that the proposal to group the Squamata, Rhynchocephalia and Ichthyosauria in a group equivalent and opposed to the one including Mesosauria, Plesiosauria and Chelonia, will meet with ready acceptance. It would, however, carry us too far to enter on this occasion into a discussion of the reasons that have determined the author to adopt such an arrangement.

But it may not be out of place here to enter a protest against the introduction of new terms for higher divisions, such as Patagiosauria for the well-known Ornithosauria or Pterosauria, Gecko-Chamæleontes s. Uroplatimorpha for the group already named Uroplatoidea by Gill and Geccovarani by Cope, on the mere ground of the new names being more expressive. *À propos* of the last-named division, it is indeed startling to learn that the long-sought ancestor of the Chameleons is believed by Prof. Fürbringer to be approximated by the curious *Uroplates* of Madagascar which, formerly placed with the Geckos, was first raised to family rank on the ground of the difference in the shape of the clavicular arch. However, the arguments brought forward by the learned professor in favour of this hypothesis do not seem very convincing.

The limits assigned to this notice do not permit of attention being drawn to the many other salient points in the new classification, and to the incidental remarks on the relationships which birds and mammals bear to the reptiles. Suffice it to say that Prof. Fürbringer's work is, like everything we owe to his marvellous industry, most elaborate and careful, and that the very complete bibliographical indications that accompany it constitute in themselves a valuable mine of information for the student of the morphology and taxonomy of the reptiles.

G. A. B.

OUR BOOK SHELF.

A Practical Guide to Garden Plants. By John Weathers. Pp. 1192 + xii. (London: Longmans, Green and Co., 1901.) Price 21*s.* net.

THE garden plants here dealt with are those which are hardy enough to be cultivated in the open air, and they comprise not only ornamental plants but fruits and vegetables. A well-constructed glossary precedes the body of the work. The earlier portions are devoted to the life-history of cultivated plants, which is well done so far as it goes, but which would bear to be considerably expanded. It is rather misleading to call oxygen, carbon, hydrogen, nitrogen and the other elementary substances which the chemist finds in plants, different kinds of food. They are the materials of which food is made, but not the food itself.

The bulk of the work is made up of descriptions of the various hardy plants generally grown in gardens, together with indications for their cultivation.

The plants named are arranged in their natural orders, which is a great boon to the amateur, greatly facilitates the acquisition of knowledge, and adds to the interest of the plant. "If the cultivator," says the author, "has even only a slight knowledge of the way in which plants have been grouped more or less naturally by botanists, he may, by the aid of his books, run the unknown plant very close, if not quite, to its own group from the characters he sees. But if his books have the plants arranged simply in alphabetical order according to their names and not according to their relationships, he may as well give up his search at once unless he has the time and inclination to wade through every name from A to Z. Indeed, descriptive plant-books, arranged in purely alphabetical order, are only of value when the proper name of the plant about which information is required is already known."

From long experience we can confirm the author's statement. It is the fashion nowadays to neglect the comparative study of plants as they now exist, but, looking at the matter from a utilitarian point of view, it is of much greater use to be able to recognise the distinctions between one natural order and another than it is to indulge in speculative and conjectural genealogies In any case, a knowledge, even though it be slight, of the principal natural orders adds greatly to the interest of a garden and often affords useful indications for cultivation. Mr. Weathers has sometimes supplied English names for the orders which appear to us as to be unnecessary—for instance, why should we have to learn that the Magnolia order is called the Lily-tree order, or why should the Leguminosæ be called the Laburnum and Broom order? The Latin names of the orders present, as a rule, little or no difficulty to those who really desire to know them. For those who do not, it is not necessary to put one's self to inconvenience. This portion of the work is excellent for reference purposes, and must have entailed great labour on the author.

The sections relating to fruit and vegetables are not so satisfactory, but, on the whole, the book is well calculated to satisfy the requirements of the amateur and of the professional gardener, the more so as it is provided with an excellent index.

Ausgewählte Methoden der Analytischen Chemie. By Prof. Dr. A. Classen. Erster Band. Pp. xx+940. (Brunswick: Vieweg und Sohn, 1901.)

THE first impression which this volume on select methods of analysis conveys is entirely favourable. The book is well printed, tastefully bound, and furnished with those delicate illustrations of apparatus which are characteristic of German chemical books.

The chief desideratum in a work on analysis is that the author shall not only be a skilled analyst, but that he shall have had personal experience of the methods which he describes.

Prof. Classen's connection with analytical chemistry, especially with the introduction of electrolytic methods, is too well known to leave any doubt as to his qualifications as an analyst, and we are assured by him in the preface that "In diesem Buche sind demnach diejenigen Methoden vorzugsweise beschrieben worden, welche ich persönlich vielfach anwandte, oder welche durch meine Assistenten und Schüler oder von dritten Seite kritisch geprüft wurden."

We can only admire the zeal and industry of the author and his assistants in having been able to examine critically even half the methods described in these 900 pages of closely printed matter. In reviewing a book of this kind, one naturally turns to the description of processes with which one is familiar. Judged by this test it fully justifies its first impressions. It is furnished with that minuteness of detail which is requisite in any book on quantitative and especially technical analysis, as this professes to be.

In addition to the estimation and separation of the commoner metals, considerable space is devoted to the rarer ones, some of which, like cerium and its allies, have recently entered the field of technical chemistry.

It seems odd that in a work relating entirely to metals

so little mention is made of metallurgical methods of assaying, which are frequently employed, not only for estimating silver and gold, but in the technical analysis of lead and copper ores. J. B. C.

Recueil de Données numériques. Optique. By H. Dufet. Part iii. Pp. 787–1313. (Paris: Gauthier-Villars, 1900.)

THE second part of this invaluable collection of physical and chemical data dealt with the optical properties of solids, and has already been described in these columns (vol. lx. p. 28). The present (and concluding) volume contains tables showing the rotatory powers of crystalline bodies, liquids and solutions, interference colours produced when rays of white light strike normally upon a layer of air of a given thickness, and supplementary tables of refractive indices, standard wave-lengths, optical properties of inorganic and organic bodies, and other data. In all cases full reference is given to the authority for the values tabulated. The Physical Society of France has done a service to science by arranging for the preparation and publication of these results, which have been gathered from many sources, and are frequently difficult of access.

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.*]

Apatite in Ceylon.

A PARAGRAPH in Prof. Miers' interesting notice (NATURE, March 7) of the results of Dr. Grünling's mineralogical expedition to Ceylon may convey the impression that Dr. Grünling was the first person to recognise, and Dr. Schiffer the first to analyse, the sky-blue apatite of Ceylon.

Now Mr. H. Willett, of Brighton, handed me several years ago a beautiful transparent specimen which I at once identified as apatite though its colour was unusual. The sky-blue, prismatically developed crystals were embedded in a white dolomitic matrix. This specimen had been brought from Ceylon by Mrs. Willett. Its exact provenance was unknown, but some spot not far from Kandy and the railway thither was suggested as the probable locality. There can be little doubt that this specimen came from the neighbourhood of Wattegama, between Kandy and Matale, where Dr. Grünling obtained the apatite analysed by Dr. Schiffer. In the *Mineralogical Magazine* for April 1899 (p. ix) will be found a notice of a paper read by me before the Mineralogical Society on January 31, 1899, just two years ago, entitled "Analyses of Ceylon Apatite." Following this title occurs the paragraph: "Prof. Church exhibited blue apatites from Ceylon, one containing as much as 3·21 per cent. of chlorine, others only 0·63 and 0·34 per cent." The last of these three figures represents the percentage of chlorine found by me in Mr. Willett's specimen.

In discussing, in the autumn of 1898, the question of Ceylon apatite with Prof. Judd and Mr. F. W. Rudler, I found that the identification of this mineral did not seem at that time to have been published. Prof. Judd was good enough to supply me with specimens from another Ceylon locality (near Newara Eliya) and having a different matrix. Here the colour of the apatite was paler and its crystalline habit indistinct. This sample gave 0·63 per cent. of chlorine.

But by far the most interesting specimens were some imperfect tabular crystals sent to me in 1898 by a gem-merchant of Colombo. These were of a much richer blue colour than any of the other examples. Indeed, my Colombo friend's attention had been drawn to them by one of his "Moormen" having brought to him, some time previously, a perfectly transparent cut gem weighing five carats, which he offered as a blue spinel! I wrote for uncut specimens, which were soon procured from the same Moorman, but he had removed them from the matrix. The locality of these specimens proved to be Avisavelle. One of these crystals it was that gave me 3·21 as the percentage of chlorine. I may add that the dichroism of this variety closely resembled that of vivianite.

I would remark in conclusion that the number of Dr. Groth's *Zeitschrift für Krystallographie u. Mineralogie* in which the blue apatite of Ceylon is described was published last year, long after the notice of my paper had appeared in the *Mineralogical Magazine*. If any earlier communication on the subject has appeared I should welcome a reference to it.

A. H. CHURCH.

Maps in Theory and Practice.

EVERY advanced treatise on astronomy defines and explains certain kinds of map projection; but in all these accounts I have been struck with the absence of any notice of the particular kind of projection with which we are most familiar—the kind usually employed for representing the world in hemispheres; in fact, the commonest kind of map projection.

I have for the first time come across a notice of it, at p. 126 of the February number of the *American Journal of Science*, in the following terms:—

"The method of projection almost universally employed by geographers for representing hemispherical surfaces is the so-called globular projection, invented in 1660 by the Italian Nicolosi (Germain, 'Traité de Projections des Cartes Géographiques,' Paris, about 1865). The equator is divided into equal parts, and the meridians are circular arcs uniting these points with the poles. The parallels are likewise circular arcs, dividing the extreme and central meridians into equal parts."

As three points suffice for determining a circle, this definition is complete for the mapping of a hemisphere extending from pole to pole. To apply it to a smaller portion of the earth's surface, let the hemisphere be so taken that this portion is centrally placed between east and west; then the central meridian will be straight.

As it is desirable that theory should be kept in touch with practice, I would commend this subject to the attention of teachers of geography and astronomy. J. D. EVERETT.

11 Leopold Road, Ealing, W., March 11.

Early Observations of Volcanic Phenomena in Auvergne and Ireland.

MR. G. P. SCROPE ("Extinct Volcanos of Central France," ed. 2, 1858, p. 30) describes how Guettard and Malesherbes, returning from Italy, met Faujas de St. Fond at Montélimar in 1751, and, in his company, founded the theory of the volcanic origin of the mountains in the Vivarais. Guettard and Malesherbes thence proceeded to Auvergne, where M. Ozy, a chemist of Clermont-Ferrand, acted as their guide. Ozy knew his ground well, and had already observed the general aspect of the rocks, since Guettard (Mém. Acad. roy. des Sciences, 1752, p. 37) says that he "m'assura . . . que je trouverois par-tout une même structure & les mêmes matières qu'il m'avoua ingénument n'avoir jamais reconnues pour ce qu'elles étoient."

Sir A. Geikie has justly written of the discoveries of Guettard ("Anc. volcanoes of Gt. Britain," preface), "To France, which has led the way in so many departments of human inquiry, belongs the merit of having laid the foundations of the systematic study of ancient volcanoes."

Considerable interest, therefore, attaches to a letter from Ozy, published by Faujas de St. Fond in 1778 ("Recherches sur les volcans éteints du Vivarais," p. 434), and written in reply to inquiries as to what authors had first visited the volcanoes of Auvergne. Ozy refers somewhat casually to his meeting with Guettard, which was already well known through the information provided by him, and fully acknowledged in Guettard's paper. But he states that a year before, that is, in 1750, he was visited by "Olzendorff," an Englishman, and "M. Bowls, irlandois," who came to inspect the adjacent lead-mines. He continues: "Nous montâmes ensemble au *Puy de Dome*, & ce fut là que j'appris pour la première fois à connoître les *cratères*, les laves, &c., car auparavant je n'étois pas plus instruit sur cet objet que les autres habitans de cette province."

It seems hardly possible to construe this passage, written in answer to a direct inquiry from St. Fond, into a confusion of the two ascents. The "ensemble" refers to Olzendorff and Bowls; "la première fois" can hardly refer to events of the subsequent year. "Bowls," moreover, was, with high probability, William Bowles the mineralogist, who is known to have

been born in Cork, and who published his work on the natural history of Spain in Paris in 1776. It would be very interesting to trace any conclusions as to extinct volcanoes that were current in Bowles's mind as early as 1750. Ozy is not likely to have made a show of his previous knowledge to men of established position like Guettard and Malesherbes, who had honoured the local apothecary with a call. He listened to their exposition of the craters, and "avoua ingénument" that he was much surprised at what he heard. After all, it was Guettard who took the matter up absolutely fresh from the beginning, and whose memoir made it for the first time public knowledge.

Bowles may have come from Catalonia, and may have formed his opinions there. I make no mention of Olzendorff, of whom I have no further trace; but the fact that Bowles instructed Ozy at Clermont, if the above contention is correct, a year before Guettard had formed his conclusions, and in an age rife with unfounded speculation, marks him as a geological observer deserving of more credit than he has yet received. I called attention to Ozy's letter in *Knowledge* for 1898, p. 266, and have since made inquiries through friends in Cork and elsewhere; but the present family of Bowles in Cork, formerly Boles, can furnish no data as to the life of the mineralogist.

An interesting inquiry also arises as to when the Giant's Causeway in Antrim was first regarded as a lava-flow. What did Bowles know of this phenomenon? Its detailed appreciation, from a geological point of view, is usually ascribed to Whitehurst, in the second edition of his work in 1786. But Faujas de St. Fond in 1778 calls many of the French lava-flows "chaussées," and clearly shows his own conclusions when he styles certain examples with good columnar jointing "pavés des géans."

GRENVILLE A. J. COLE.

Royal College of Science for Ireland, Dublin, March 1.

Probability—James Bernoulli's Theorem.

IT may possibly be of some little interest to notice that the theorem in probability, which goes by the name of James Bernoulli's theorem, alluded to in my letter to NATURE of December 13, 1900 (p. 154), admits of a treatment somewhat more elementary than the usual one.

The theorem may be stated thus:—If p is the probability of a given event, and n the number of times considered; as n increases without limit, the probability that the ratio of the number of times in which the event happens to the whole number of times (n) will only deviate from p within limits of excess and defect, which decrease indefinitely as n increases without limit, is a probability which approaches indefinitely to unity as its limit.

In Laplace's demonstration (see Todhunter's "History of Probability," art. 993) Stirling's theorem, for the evaluation of factorials, is used in the first step; in the second step the theorem of Euler,

$$\Sigma y = \int y\,dx - \tfrac{1}{2}y + \tfrac{1}{12}\frac{dy}{dx} - \ldots$$

which is also implied in the usual proof of Stirling's theorem; and, finally, the result depends on the evaluation of the well-known definite integral $\int_0^r e^{-t^2}dt$.

Further, it is essential to this demonstration to make the limit of deviation in excess from the ratio p equal to the limit of deviation in defect, for then as members of the series, which represent the probability sought, equidistant from the middle of the series contain certain terms equal in magnitude and of contrary sign, these terms cancel in the addition of such pairs, and are thus got rid of.

It may be shown that the general result of Bernoulli's theorem may be got without the above described use of Euler's theorem (*i.e.* the second use of it), without using the evaluation of $\int_0^r e^{-t^2}dt$, and without making the limits of excess and defect equal. These limits may have any ratio whatever.

Let q be the probability that the event does not happen, so that $p+q=1$.

Let the whole number of times considered be $y+x$. Since this is to increase without limit, we may suppose $p(x+y)$ and $q(x+y)$ always integers.

Let P be the probability that the number of the times in which the event happens be between $p(x+y)+ax$ and $p(x+y)-bx$ where $(a+b)=1$, so that x represents (so to speak) the range of the variation, a and b may have any ratio to one another. Assume that $y=mx^{2(1-\kappa)}$, where κ may be as small as we please, but finite. Thus P is the probability that the ratio of the times when the event happens to the whole number of times shall not exceed p by more than $\frac{ax}{x+y}$, or fall short of p by more than $\frac{bx}{x+y}$; limits which vanish when x and y are infinite.

Let P_1 = probability that the number of times in which the event happens is less than $p(x+y)-bx$, and P_2 the probability that it exceeds $p(x+y)+ax$. Then $1-P=P_1+P_2$.

$$P_1 = p^{x+y} + (x+y)p^{x+y-1}q + \ldots + \frac{(x+y)!\,p^{p(x+y)+ax+1}q^{q(x+y)-ax-1}}{\{p(x+y)+ax+1\}!\,\{q(x+y)-ax-1\}!}.$$

Now P_2 evidently = the probability that the number of cases in which the event does not happen is less than $q(x+y)-ax$, and therefore the series for P_2 is derivable from that for P_1, by interchanging p and q, and by interchanging a and b. These values of P_1 and P_2 may, of course, be also got from the equation

$$P_1+P_2=(p+q)^n-P.$$

P_1 is evidently less than the geometrical progression of which the sum is

$$\frac{(x+y)!\,p^{p(x+y)+ax}q^{q(x+y)-ax}}{\{p(x+y)+ax\}!\,\{q(x+y)-ax\}!}\cdot\frac{\left\{\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}\right\}^{q(x+y)-ax+1}-1}{\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}-1}$$

By Stirling's theorem, x and y increasing *ad. inf.*

$$(x+y)! = (x+y)^{x+y+\frac{1}{2}}e^{-(x+y)}\sqrt{2\pi}\left(1+\frac{1}{12(x+y)}+\ldots\right)$$
$$= y^{x+y+\frac{1}{2}}\left(1+\frac{x}{y}\right)^{x+y+\frac{1}{2}}e^{-(x+y)}\sqrt{2\pi}\left(1+\frac{1}{12(x+y)}+\ldots\right),$$

and similarly for the other factorials.

Thus the above expression becomes

$$\frac{1}{\sqrt{2\pi pq}}\cdot\frac{\left(\frac{1}{12(x+y)}+\ldots\right)}{\left(1+\frac{1}{12(p(x+y)+ax)}+\ldots\right)\left(1+\frac{1}{12\{q(x+y)-ax\}}+\ldots\right)}\cdot\frac{\left(1+\frac{x}{y}\right)^{x+y+\frac{1}{2}}}{\left(1+\frac{(a+p)x}{py}\right)^{p(x+y)+ax+\frac{1}{2}}\left(1+\frac{(q-a)x}{qy}\right)^{q(x+y)-ax+\frac{1}{2}}}\cdot\frac{1}{y^{\frac{1}{2}}}\cdot\frac{\left\{\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}\right\}^{q(x+y)-ax+1}-1}{\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}-1}.$$

The limit of the second factor is unity. The third factor may be shown to become in the limit

$$\frac{1}{\frac{a^2}{e^{2mpq}}\,x^{2\kappa}}.$$

The limit of

$$\left\{\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}\right\}^{q(x+y)-ax+1}$$

is the limit of e^{-cx}, and the limit of

$$y^{\frac{1}{2}}\left(\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}-1\right)=-hx^{\kappa},$$

where c and h are positive constants. Hence the limit of the product of the factors is zero—that is, the limit of P_1 is zero, and evidently also the limit of P_2.

Hence the limit of P is unity.

The range of the deviation (x) is greater in this proof than in the usual one, for in the latter x would vary as $y^{\frac{1}{2}}$ as against $y^{\frac{1}{2-2\kappa}}$ where κ may be as small as we please.

A further simplification would be introduced by a method of evaluating the series P_1 or P_2 without the use of Stirling's theorem. Such a method has been given me by Mr. G. G. Berry, of Balliol College, and may be briefly described as follows:—

If in the expansion of $(p+q)^n$ we stop t terms before the greatest, the truncated series has a smaller sum than the G.P., which has the same two final terms. If t^2 is great as compared with n, the G.P. has a sum which vanishes compared with its final term multiplied by $\sqrt{n}$. But the product of the greatest term of $(p+q)^n$ and $\sqrt{n}$ is finite; for the sum of $\sqrt{n}$ terms on either side of the greatest <1, and the ratio of the greatest term to a term distant from it by $\sqrt{n}$ places is—

$$\frac{\left(1-\frac{1}{pn}\right)\left(1-\frac{2}{pn}\right)\cdots\left(1-\frac{\sqrt{n}-1}{pn}\right)}{\left(1+\frac{1}{qn}\right)\left(1+\frac{2}{qn}\right)\cdots\left(1+\frac{\sqrt{n}}{qn}\right)},$$

which has a finite limit.

J. COOK WILSON.

Oxford.

A Tree Torn by Lightning.

I ENCLOSE two photographs of an oak tree struck by lightning, which seem of interest.

The storm, one of considerable violence, occurred on July 27, 1900, and continued for several hours. The tree stood by the side of a road which runs over the Chilterns from Ipsden, a little village about five miles from Wallingford and ten from Henley. It was standing at the western edge of a small stretch of woodland. The opposite side of the road was quite clear and sloped down to the plain.

FIG. 1.

On examination, the bark was found to be completely stripped off and flung on one side; a large branch was torn away, and the fractured end was extraordinarily splintered and smashed. So far as I saw there were no signs of charring.

The inner surface of the bark was marked longitudinally with thin wavy lines, very close-set, of which the crests were about ¼ inch apart.

The first photograph gives a general view of the tree; the second represents the lower side of the bent portion of the

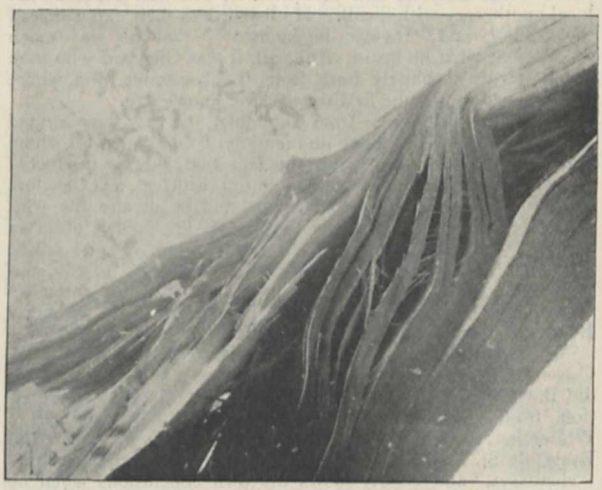


FIG. 2.

trunk, and shows very clearly the rending effect of the lightning on a fibrous tissue.

The photographs were taken about a fortnight after the tree was struck, during which time there had been much wind and rain.

PERCY E. SPIELMANN.

Adaptation of Instinct in a Trap-door Spider.

THE following extract from the *Sydney Bulletin*, January 12, sent to me by a correspondent in Western Australia, recounts an observation sufficiently interesting, I think, to be reprinted and put on permanent record in a scientific periodical:—"A friend of mine noticed near his camp a trap-door spider run in front of him and pop into its hole, pulling the 'lid' down as it disappeared. The lid seemed so neat and perfect a circle that the man stooped to examine it, and found, to his astonishment, that it was a sixpence! There was nothing but silk thread covering the top of the coin, but underneath mud and silk thread were coated on and shaped convex (as usual). The coin had probably been swept out of the tent with rubbish."

As is well known, the doors of trap-door spiders' burrows are typically made of flattened pellets of earth stuck together with silk or other adhesive material. The unique behaviour of the spider in question showed no little discrimination on her part touching the suitability as to size, shape and weight of the object selected to fulfil the purpose for which the sixpence was used.

R. I. POCOCK.

March 6.

Protective Markings in Cats.

IT will probably appear to many—as it does to myself—that the development of a protective mechanism in a domestic animal is not likely, and for several reasons—such as the shortness of time at the disposal of the race, and, of course, to their large independence of stress of circumstances. Still it may be admitted that the domestic cat bears its subjugation to man more lightly than many of the other creatures which he has tamed. The particular mark above the eye to which your correspondent refers (p. 441) has also been pointed out by Mr. Wallace in the dog. It may interest those of your readers who are not aware of the fact to learn that the tiger has a largish and very bright white spot upon the back of the ear. When the ears are directed forwards this spot is exceedingly conspicuous from in front (as any one may verify upon the fine pair of tigers now in these gardens); and, in the dimness of a cave or a thicket, might conceivably produce an impression of alertness when the animal was really sleeping.

Zoological Society's Gardens. FRANK E. BEDDARD.

FURTHER OBSERVATIONS ON NOVA PERSEI.[1]

SINCE the preliminary note on this star was communicated to the Royal Society on February 28, observations have been possible on the nights of February 28, March 1, 3 and 5, and twenty-four photographs of the spectrum have been taken with the instruments before detailed.

It may be stated generally that the light is slowly waning. On February 28 the star was only slightly brighter than *a* Persei. On March 1 it was estimated as about equal to *a* Persei *i.e.* about 2·0 magnitude. When it was again visible, on the evening of March 3, it was distinctly less bright than *β* Persei, and its magnitude probably near 2·5. On the 5th its estimated magnitude was 2·7.

The above refers to the visual brightness. A photograph of the region occupied by the Nova on March 3 showed it to be photographically brighter than *a* Persei.

General Description of the Spectrum.

The photographs show that the bright hydrogen lines are successively feebler as the ultra-violet is approached, and the whole of the series of hydrogen lines have, during the past week, become relatively brighter with respect to the remaining lines and the continuous spectrum. The spectrum extends far into the ultra-violet.

Among the changes which have taken place in the visible part of the spectrum, it may be mentioned that, while the lines of hydrogen have become relatively brighter during the past week, the remaining lines, with the possible exception of the prominent one at λ 5169, have become distinctly dimmer. There has also been a diminution of the intensity of the continuous spectrum. The line in the yellow, the identity of which has not yet been definitely determined, has gradually decreased in intensity with the diminution of brightness of the star. The bright green-blue F line of hydrogen has become more conspicuous as the neighbouring green lines have become fainter, and the bright C line is intensely brilliant.

From all these causes, which give us blue light on the one hand and red on the other, the star should present to us the precise quality of red which has been observed.

Colour.

At discovery the star was described as bluish-white. No observations on its variation in hue during its brightening were possible, owing to unfavourable weather conditions. The observations during the period of decline have indicated a change to the present colour of a decided claret-red. In comparison with this it is interesting to note that in the case of the Nova which appeared in 1604, Kepler alludes to purple and red tints assumed by the star.

Changes in the Photographic Spectrum.

Between February 25 and March 5, to take the extreme difference of dates on which photographs were obtained, it has been noted that while some of the dark lines were absent on the later date, either new lines had come in or previously feeble lines had become intensified. There has not yet been time to determine accurately the positions of these lines. The appearance of the bright lines of hydrogen, which I described as being reversed on February 25, had very materially changed by March 3.

In inspecting the dark band representing the bright hydrogen at Hϵ, two darker fine lines are seen nearly coincident in position with the edges of Hϵ in the spectrum of *a* Persei photographed on the same plate.

The appearance in the case of the "F" line (Hβ), is seen by the accompanying light curve (Fig. 1).

[1] Abridged from a paper read at the Royal Society on March 7, by Sir Norman Lockyer, K.C.B., F.R.S.

No doubt the differences in the appearances are due to a fact that at Hϵ we are dealing with the lines both of H and Ca.

Rough measurements on the bright line Hβ show that the interval between the centres of the two extreme maxima shown in the light curve corresponds to about 25 tenth-metres. This would give a differential velocity of 960 miles per second between the different sets of hydrogen atoms in the bright line swarm itself.

It may be, then, that the appearances described as reversals of the hydrogen lines on February 25 were but the beginning of the subsequent changes.

The comparisons with stars which have been taken with the slit-spectroscope on each evening of observation, indicate that no great change in the velocity of the dark line component has occurred. So much, however, cannot

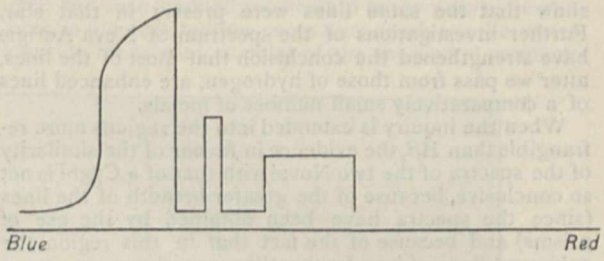


FIG. 1.

be said of the bright lines in which a change has been observed.

In addition to the hydrogen lines, the strong lines in the green already ascribed to iron appear to be double in the photographs most recently obtained.

Comparison with a Cygni.

The view of the apparent similarity between the spectra of Nova Persei and Nova Aurigæ, to which I drew attention in my previous paper, has been strengthened by the comparisons which have since been made.

The bright lines in the spectrum of Nova Persei are so broad, especially in the blue and violet, that accurate determinations of their wave-lengths are difficult to obtain. The lines less refrangible than F, however, besides being more isolated, are narrower than those in the more refrangible part of the spectrum. A direct comparison of these with the lines in the spectrum of a star which is known to contain the enhanced lines of iron, &c., has been considered a better method of arriving at some definite conclusion as to the connection between the Nova lines and the enhanced lines than that of determining the wave-lengths of the broad lines and comparing the results with the known wave-lengths of the enhanced lines.

The best star for this purpose is *a* Cygni, but, unfortunately, no good photograph has been obtained at Kensington of the green portion of the spectrum of that star. The star most nearly approaching *a* Cygni in relation to enhanced lines is *a* Canis Majoris, which, in the Kensington classification, has been placed nearly on a level with the former star, but on the descending side of the temperature curve. In the spectrum of this star the enhanced lines of iron at λλ4924·1, 5018·6, $\begin{cases} 5169{\cdot}0, \\ 5169{\cdot}2 \end{cases}$ and 5316·9 occur as well-marked lines. This spectrum has been directly compared with that of Nova Persei, taken with the same instrument, and the fact that all the lines apparently coincide affords good evidence that the connection is a real one, and that the first four strong Nova lines beyond F on the less refrangible side are the representatives of the enhanced lines of iron. These are the only enhanced lines which occur in that part of

the iron spectrum, with the exception of a weak one at λ 5276. There is only a trace of this line in the spectra of either the Nova or *a* Canis Majoris which have been compared. In the spectra of the Nova obtained with lower dispersion, however, a line is distinctly shown in this position, though it is considerably weaker than the four lines previously mentioned.

The absence of the strong lines which are familiar in the arc spectrum and in the ordinary spark spectrum in this region is to be ascribed to higher temperature; experiments which are in progress show that under certain conditions the two lines λλ 5018·6 and 5169 are by far the strongest lines in the spectrum of iron between λ 500 and D, while that at λ 4924·1 is distinctly stronger than any of the well-known group of four arc lines in which it falls.

The published wave-lengths of the lines of Nova Aurigæ show that the same lines were present in that star. Further investigations of the spectrum of Nova Aurigæ have strengthened the conclusion that most of the lines, after we pass from those of hydrogen, are enhanced lines of a comparatively small number of metals.

When the inquiry is extended into the regions more refrangible than Hβ, the evidence in favour of the similarity of the spectra of the two Novæ with that of *a* Cygni is not so conclusive, because of the greater breadth of the lines (since the spectra have been obtained by the use of prisms) and because of the fact that in this region the enhanced lines of iron frequently occur in groups.

In the region between Hδ and Hγ, however, there is a well-marked enhanced line of iron at λ 4233·3, and also two doubles at λλ 4173·7, 4179·0, and λλ 4296·7, 4303·3, and a comparison of *a* Cygni with Nova Persei indicates that these fall on broad bright bands of the Nova spectrum. NORMAN LOCKYER.

MR. BORCHGREVINK'S ANTARCTIC EXPEDITION.[1]

MR. BORCHGREVINK succeeded in an enterprise of which he may be justly proud. Unknown and without external influence, by the force of his immense ambition and determination, he obtained the support of a man of great wealth, and unaided, if also untrammelled, by Government, learned societies or committees of any kind, he equipped an expedition, selected a scientific staff, spent a winter on land in the Antarctic regions for the first time in history, and made his way to a point nearer the South Pole than had ever been reached before. For doing this he deserves praise and honour. With his motives we have no concern; they appear to have been partly commercial and partly scientific, but in these columns we can only treat the expedition from a purely scientific point of view, forming our opinions from the facts placed before us in the book.

Mr. Borchgrevink chose his ship well, and she proved to be as stout and powerful a steam-whaler as ever put out from Norway. He chose his scientific staff well, and they appear to have worked conscientiously and to have obtained results which cannot fail to advance knowledge if they are properly discussed and published. He chose his sailing master, Captain Jansen, well, and he appears to have conducted the expedition without a hitch or any trace of insubordination. Mr. Borchgrevink was able to repeat in his steamer Sir James Clark Ross's sailing-ship voyage, and saw again Mounts Erebus and Terror; he landed on the southern ice, and advanced a few miles beyond the edge of the previously known world.

The book is short—an excellent thing in accounts of travel; the author has a certain power of observation and description, as the chapter on the habits of penguins and many little episodes of personal adventure show. His illustrations are remarkably fine, admirable reproductions of good photographs, and they are introduced with a lavish hand.

This is the bright side of the medal; the reverse is not so pleasing. Mr. Borchgrevink would have done better if he had had another chronicler, for his literary style does him less than justice. We can excuse an author, whose forte is action rather than study, for attributing incorrect titles to English men of science, but he might surely be expected to give correctly the names of his own distinguished countrymen, amongst whom Dr. Hjort appears as *Hjorth*, and Dr. Reusch in one place as *Reush* and in another as *Rusch*. Although the book is small we can hardly attribute these slips to anything but haste in correcting the proofs. We wish we could find an equally satisfactory explanation of other errors of a more serious kind.

We fear that Mr. Borchgrevink did not set his ambition high enough, and did not endeavour to make himself acquainted with the elementary principles of the various sciences which the members of his staff were pursuing. During the long Antarctic night he might easily have learned from his skilled assistants more than sufficient to have enabled him to give an intelligible sketch of the work of his expedition, even if time had been wanting at an earlier period. That he did not do so is to be inferred from the following circumstances, to which we call attention with real regret and which we would have passed over gladly were it not that the objects of the expedition have been generally spoken of as scientific.

On p. 63 there is given what purports to be a fully worked example of the calculation of the longitude from observations of the sun taken near Balleny Island,[1] by means of a Cary 10-inch sextant. The index error was found to be "14 in." off the arc—a possible printer's error for 14″, one would think; but further down the error is given as 14′ 0″. However, the sun's semidiameter is also estimated at the excessive value of 16° 17′ 1″, and this gives us a clue to the system of notation employed for the corrections, though not for the instrumental reading. It is simply to write minutes as degrees, seconds as minutes and decimals of a second as seconds. Working out the calculation on this assumption the final corrected altitude is obtained as stated. On p. 64 the curious blunder of "Lysin Sq.," probably intended for "Log Sin²," and several others equally absurd have escaped the author's vigilance, and the logarithms set down are not what we would expect.

Is this an elaborate joke played by the author on the public, or is it a joke played on the author by some person unknown and not detected by him? We cannot think that it was meant seriously, and we cannot see why the example was ever given, as no one has any interest in disputing the position of Balleny Island. The actual figures and working of the really critical observation which convinced Mr. Borchgrevink that he had got further south than Sir James Ross might have been quoted reasonably enough, but are not. If any credence is to be given to the position of the expedition at any date, the serious question raised by this worked specimen must be answered.

On p. 136 we read, "Only Jupiter and its stars and Centauri were visible." So much for astronomy.

With regard to meteorology the same indifference to figures occurs. In more than one place the height of the barometer is given in the form "29.7.1," although elsewhere the readings are expressed in the usual way. The vaguest references are made to instrumental observations; for instance, a graphic account is given of the difficulty of placing a thermograph at 2000 feet on Cape

[1] "First on the Antarctic Continent; being an account of the British Antarctic Expedition, 1898-1900." By C. E. Borchgrevink, F.R.G.S., Commander of the Expedition. With portraits, maps, and 186 illustrations. Pp. xvi+334. (London: George Newnes, Ltd., 1901.)

[1] Balleny Island is stated, on p. 3, to be a volcano 12,000 feet high; here there is evidently some confusion with Mount Erebus.

Adare, and of returning for it a week later; but its readings are not noted. The "anti-cyclonic theory" is referred to, but neither discussed nor explained.

"Characteristic stratification of the rocks" is referred to on p. 223, and some of the photographs do appear to show lines of bedding; but we are left in doubt as to whether the author realises the great interest of discovering such rocks on the Antarctic continent. In the preliminary report on the rock-specimens by Mr. J. T. Prior, in the appendix, there is no reference to anything most like stratified rocks than a "pale green slate and quartz grit," of which no particulars are given. On p. 264 we read of "a huge cauldron, the bottom of which was even below the sea-level, but guarded against the waters of the cove to the west by a narrow ridge of brimstone"; but this unusual structure does not seem to have been investigated.

As to biology, birds are always referred to by their full names, generic and specific; but the seals are simply termed "Weddelli" (a name used to distinguish this seal vaguest descriptions of where he went or what he saw. As he climbed a glacier on one occasion—"step by step we rose until we were a few thousand feet up, as indicated by the aneroid." This is offering a stone to the reader who hungers after definite information. The log of the crossing of the pack by the *Southern Cross* on four separate occasions might be expected to yield most important hints to the forthcoming Antarctic expeditions; but details are only given of one of these crossings. The description of the southern ice-barrier, which was dismissed in a few lines by Mr. Borchgrevink in his paper to the Royal Geographical Society, was looked forward to with the keenest interest; but in this matter we find the most tantalising reticence. The famous ice-barrier, we are told, is only from 60 to 70 feet high (about one-third of the height assigned by Ross), and at the point where a landing was made it was only 2 or 3 feet, and rose gradually southward to the normal height. There is no information as to the depth of the water alongside the barrier, a point of the most vital moment.

FIG. 1.—A Crystal Palace. From "First on the Antarctic Continent." By C. E. Borchgrevink.

from the sea-leopard) or "Rossii," as the case may be, without indication of their genera. Biological theory is handled thus in speaking of what is called "bi-polarity" (p. 232).

"The existence of organisms does not develop from the presence of the possibility of existence for these, but because the element necessary for the development of these organisms was brought into conditions which favoured its development into a complete organism. It seems thus that the fount whence the element of these organisms rises exists both within the Arctic and Antarctic Circles, apparently without any communication through the intermediary zones."

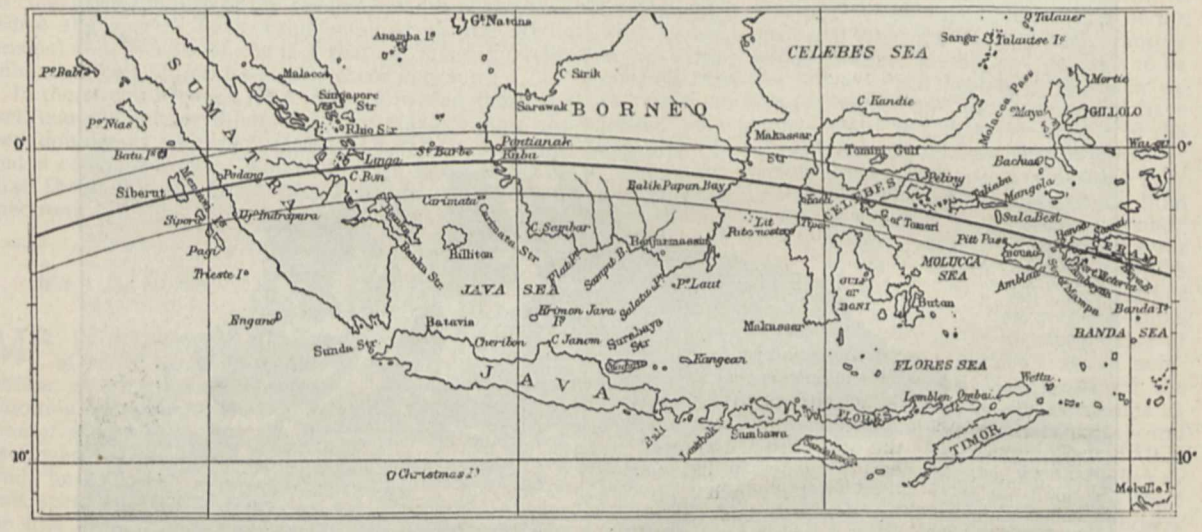
In dealing with geography there is an equal want of sense of proportion, definite information or clear ideas. The description of the coast of Victorialand is far less definite than Ross's. No connected account is given of the land-explorations which were carried out near Cape Adare. Mr. Borchgrevink states that he was away from his camp for so many days or weeks, but gives the One sounding does, indeed, figure on the map, but the exact point to which it applies is not indicated. The remarkable fact that the position of the ice-barrier was found to be many miles further south than reported by Ross is not commented on. A long digression on icebergs and pack-ice is interposed in the middle of the twelve lines of description given to the part of the world where no one had ever been before. It concludes, "With a sufficient number of reindeer, sledges and dogs, and a very small party of scientific men, I believe that a great southern latitude may be reached on this ice-sheet in the proper longitude," but never a word as to what the proper longitude is.

On pp. 270–71 we read, "We secured valuable photos. of Mounts Erebus and Terror, the former being in activity;" but will it be believed that these "valuable photos" are not reproduced? This is, we confess, the most staggering circumstance about the book. Dozens of excellent pictures are given which possess absolutely no scientific value, but the one which, of all others, the

geographer and geologist would like to examine has been kept back although it turned out a success.

The publication of his book will, we fear, tend to detract from the reputation which Mr. Borchgrevink has unquestionably merited by his organising power, his invincible perseverance and his successful completion of a considerable task. Had he been content to leave the the discussion of matters which he did not understand to the skilled members of his staff, and had he encouraged them to discuss and describe their observations, his expedition would have redounded to his credit in scientific circles, as well as amongst lovers of adventure. We believe that the extensive collections are being examined and described by specialists in the British Museum; and we hope that the magnetic and meteorological work will also be discussed by experts and published in detail. Some results in an unreduced form are given in the appendix, the most important being Mr. Louis Bernacchi's excellent summary of the meteorological and magnetic observations, which is somewhat fuller than that published previously in the *Geographical Journal*.

It is painful to us to be obliged to touch on the limitations of a strong and courageous explorer, but we cannot pass by without protest so striking an instance of the inability of an unscientific chief to appreciate the nature of the problems which his scientific subordinates are investigating or the results they obtain.



Part of the path of the moon's shadow during the total solar eclipse of May 17–18, 1901. Reproduce from the *Nautical Almanac Circular*, No. 18.

THE TOTAL ECLIPSE OF THE SUN, MAY 18, 1901.

THE approaching total eclipse of the sun is a notable one, not only on account of the unusually long duration of totality at the most favoured stations, but also because it occurs very near a time of minimum sun-spots. An exceptionally good opportunity of studying the corona at an important phase of the solar period is thus afforded, provided always that the sky is unclouded at the critical times.

The shadow strikes the earth a little to the south-west of Madagascar, traverses a north-easterly path across the Indian Ocean, passing over Mauritius and entering Sumatra near Padang, continues eastward across the southern part of Borneo, deviates to the south-east through the Celebes and the southern part of New Guinea, and leaves the earth in long. 156° 58′ E., lat. 12° 50′ S. (See accompanying map.)

While the weather prospects at most of the possible stations of observation are, unfortunately, not of the best, there is sufficient encouragement in the meteorological statistics to hope that records of the phenomena will be secured at at least one place.

In Mauritius, in the neighbourhood of the Royal Alfred Observatory, where the duration of totality is 3m. 35s., the chances of fine weather at eclipse time are very hopeful. Mr. Claxton, the director of the Observatory, states that on only two occasions since 1874 has the sky been overcast at 9 a.m. on May 18, on sixteen occasions it has been less than half covered, and on nine occasions practically cloudless (*Journal* of the Brit. Ast. Assoc., vol. xi. p. 121).

In the Malay Archipelago, where the maximum duration of totality on the central line is nearly 6½ minutes, the weather prospects are not quite so good. At Padang, on the west coast of Sumatra, which is one of the most accessible and otherwise most suitable stations, the percentage clearness during May is only 28, as against 50 per cent. for the Makassar Strait between Borneo and Celebes (NATURE, vol. lxiii. p. 163).

In these circumstances, it seems particularly desirable that the observers should be as widely distributed as possible, so as to diminish the risk of total failure to secure observations. This multiplication of stations, however, is rendered impracticable in this instance by the comparatively small number of astronomers at liberty to undertake the long voyage involved, and to some extent also by other causes, not among the least forcible being the undesirable presence of savage races at some places near the central line.

Arrangements have been made by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies to attempt to secure observations at Padang and Mauritius. At the former station will be Mr. Newall and Mr. Dyson, who will be joined by Mr. Atkinson as a volunteer, and at the latter Mr. Maunder will work in conjunction with Mr. Claxton. While it is to be regretted that other British observers of experience do not find themselves in a position to join the expeditions, there is consolation in the fact that parties from other countries have arranged to make observations. We understand that Holland will be represented by an expedition under Dr. Nyland, of Utrecht, who will be

accompanied by W. H. Julius and W. H. Wilterdinck, of Leiden, and will probably make Padang his head-quarters. Somewhere in the neighbourhood of Padang, also, the American astronomers, Prof. Barnard and Prof. Todd, together with a party from the Washington Observatory, and another party from the Lick Observatory, are expected to set up their instruments. Prof. Campbell has selected Mr. C. D. Perrine to take charge of the expedition from the Lick Observatory, and this observer will be accompanied by Mr. R. E. Curtiss, of the Observatory at Berkeley; the expenses of the expedition will be defrayed by the well-known liberal benefactor to science, Mr. W. H. Crocker, of San Francisco. The *Observatory* has further learned, through Father Cortie, that certain members of the Calcutta Jesuit Mission will also go to Padang to observe the eclipse.

The most direct route to Padang from Europe is by the Rotterdam-Lloyd line of steamers; a steamer leaving Southampton on April 9 and Marseilles on April 18 is due at Padang on May 12, and there is a return steamer on May 24, due at Marseilles on June 18. Return tickets at greatly reduced rates may be obtained through the British Astronomical Association.

As to the work to be undertaken, the great duration of totality emphatically demands that almost every effort should be directed towards the corona. Indeed, the study of the chromosphere and prominences during eclipses may well be considered to have reached a halting-place, so that in any case the study of these appendages would be considered of secondary importance. The great success which has attended the observation of recent eclipses has in some degree placed observation ahead of solar theory, and it is perhaps for this reason that most of the observations which, we understand, are to be undertaken are along familiar lines. To a certain extent this is, of course, inevitable, for it is always rightly regarded as a prime duty to record the phenomena as completely as possible.

Adequate provision is made for securing pictorial records of the corona. Some of these will be on a large scale to show the finer details of the lower reaches, and others on a smaller scale to depict the extensions seen with the naked eye. Messrs. Maunder and Claxton will utilise the photoheliograph of the Mauritius Observatory, giving pictures of the sun nearly 8 inches in diameter, and in addition will be provided with a 4-inch coronagraph fitted with a negative enlarging lens to give images 2 inches in diameter; the long extensions will be specially attacked with a 4-inch Dallmeyer R.R. lens of 32 inches focus.

At Padang, Mr. Dyson will erect the Thompson photoheliograph of 9 inches aperture, which was successfully employed by the Astronomer Royal in India and Portugal, the photographs being enlarged by a magnifier to a scale of 4 inches to the sun's diameter. The same observer will also take charge of a double camera with 4-inch lenses of relatively short focus to grasp the feeble rays of the longer streamers.

It is probable that Prof. Barnard's instrument will be the coronagraph of 61 feet focus, with which he obtained such admirable photographs of the prominences and inner corona last May. Prof. Todd will again employ his wholesale method of obtaining photographs with cameras in which the exposures are given and plates changed automatically. Coronagraphs of 33 feet 3 inches and 5-feet focus will form part of the equipment of the Jesuit Mission.

For the spectroscopic records, Mr. Maunder is provided with the 2-inch prismatic camera with which Mr. Evershed secured valuable photographs during the eclipse of 1898. With this type of instrument, the principles of which are now sufficiently familiar to render a description superfluous, the spectra of both corona and chromosphere are recorded in the most complete manner. A modified prismatic camera, in the form of an objective grating, will be employed by Mr. Newall in an attempt to photograph the coronal rings. Mr. Dyson will again employ the two slit spectroscopes belonging to Captain Hills, which were used in India and Portugal, one of them being specially adapted for the ultra-violet spectrum. Another important spectroscope will be the prismatic camera forming part of Dr. Nyland's equipment; this consists of a 6-inch objective and two prisms of 45°, thus duplicating one of the instruments employed in the last two eclipses by Sir Norman Lockyer. The Jesuit Mission will investigate the spectroscopic phenomena with a Rowland concave grating of 36 inches focus, and a prismatic camera of 33 inches focus.

In the case of the slit spectroscopes and the objective grating, the long duration of totality will obviously be an immense advantage, and it is very desirable also that the experiment of giving very long exposures with the prismatic cameras should be made.

Among the more special inquiries, Mr. Newall will again attempt to investigate the rotation of the corona, and also to obtain photographs of the corona in polarised light. The first of these observations is a particularly delicate one, depending for its success on photographically recording the coronal spectrum with sufficient dispersion to exhibit the minute displacements of the bright lines produced by the rotation. The long duration of totality is especially favourable for this observation, but, on the other hand, there is evidence that at the time of sun-spot minimum the coronal lines are of but feeble intensity. Success is therefore by no means assured, but the slit spectroscope to be employed in the experiment is one of great efficiency and convenience, and the attempt is well worth making.

The study of the polarisation of the coronal light is also of some importance. The luminosity of the corona, apart from that due to the luminous gases of the inner corona, has been ascribed to the reflection of solar light by the small particles of which it is supposed to consist, and to the direct emission of light by such particles rendered incandescent by solar radiation. The bolometric observations of Prof. Langley's party at the last eclipse, however, led to the conclusion that the corona appears "neither to reflect much light from the sun, nor, chiefly by virtue of a high temperature, to give light of its own, but seems rather to be giving light in a manner not associated with high temperature" (NATURE, vol. lxiii. p. 67). On the other hand, Mr. Newall, during the same eclipse, found a marked polarisation of the coronal light, indicating that a considerable proportion of the light is reflected. The accumulation of additional data bearing on the origin of the light of the corona, therefore, seems very desirable.

The fact that a British man-of-war will be sent to Padang to render assistance to Messrs. Dyson and Newall is a sufficient guarantee that an adequate record of the general phenomena of the eclipse will be made.

A. FOWLER.

RED RAIN.

AN unusual, though it can scarcely be called a rare, meteorological phenomenon is reported from Italy, and has been made the subject of much highly coloured descriptive writing in the daily Press. The plain facts are thus given by Reuter's correspondent in Palermo in a telegram dated March 10:

"Since last night a dense lurid cloud has hung over this town. The sky appears of a sinister blood red hue, and a strong south wind is blowing. The drops of rain

that fall are like blood. The phenomenon, which is known by the name of blood rain, is attributed to dust from the Sahara Desert, carried here by the wind." And the Rome correspondent of the Agency on the same date says: "The phenomena reported from Sicily have also been observed in Southern Italy. The sky here has a yellow tint, and a violent sirocco is sweeping over the city. At Naples showers of sand have fallen, and the phenomenon of the Fata Morgana has been observed, the sky being of a deep red colour."

Later reports from Algiers describe the same occurrence in North Africa, and the explanation suggested is no doubt correct. It is simply a case of fine sand raised to a great height by one of the "dust devils" or whirlwinds of the Sahara, and carried by the movement of the upper air to a considerable distance before the particles, resisted in their fall by the friction of the air, have succeeded in reaching the ground. If rain happens to fall through such a cloud of suspended dust it naturally carries down a good deal of the material with it, and leaves red stains on drying up. If there is no rain, the fall of dry dust takes place all the same, and this effect is well known at sea in the trade-wind belt west of the Sahara.

It must be remembered that another kind of "blood rain," even more effective in appealing to the fears of the ignorant and superstitious, owes its alarming tint to the presence of minute organisms similar to those of red snow.

Dust rains of one kind or another are fairly frequent. Those of "sulphur" have been traced to the pollen blown abroad from conifers in the spring, and those of "ink," unhappily commoner in this country, to the catching up of smoke from manufacturing districts. Such a black rain, accompanied by intense darkness, fell over nearly 500 square miles in the north of Ireland in February 1898 during a spell of north-easterly wind, while in May 1899 a similar phenomenon was reported over an equal area of central and south-western England.

The precise atmospheric conditions necessary for the raising of dust or smoke into the upper parts of the atmosphere, and for the concentration and descent over special areas, is not yet fully understood; but the careful meteorological observations now made in many parts of Italy may be expected to throw some light on the general phenomenon when dealing with the recent occurrence.

DR. G. M. DAWSON, C.M.G., F.R.S.

GEOLOGICAL science, and Canada in particular, have suffered an irreparable loss in the death of George Mercer Dawson, C.M.G., LL.D., F.R.S., the director of the Geological Survey of that Dominion. He was born at Pictou, Nova Scotia, on August 1, 1849, and was the eldest surviving son of the late Sir John William Dawson, whose death was recorded in NATURE for November 23, 1899.

After studying at the McGill University in Montreal, he came to London and entered the Royal School of Mines in 1869. Here he gained the Duke of Cornwall's scholarship and the Edward Forbes and Murchison medals, thus passing with distinction as an Associate of the School. The training which he received in biology, as well as in geology and mining, was of essential service in his after career.

Having returned to Canada, he was in 1873 appointed geologist and botanist to the North American Boundary Commission, and two years later he joined the staff of the Geological Survey of Canada, becoming assistant director in 1883 and director in 1895.

For nearly thirty years he was thus actively engaged in field-work, gaining a broad and firm grasp of the leading features in the geology of Canada. If, as he himself remarked, much of his work was "of an exploratory character, and only occasionally, and then to a limited extent, precise or finished," it has been none the less important in advancing the science of geology and in furthering the development of the mineral resources of the Dominion. Far better equipped as a pioneer than was possible in the early days of geology, and keen in the examination of fresh ground, his enthusiasm was tempered only by the reluctance in leaving unsolved those problems which required further detailed study. In spite of constitutional infirmity, he possessed a marvellous amount of energy, while as a companion and leader he gained the confidence and affection of all who had the privilege of working with him.

His contributions to science, though mainly geological, were imbued with a general knowledge of natural history, and included observations on such subjects as seals, locusts and freshwater sponges. In geology he dealt at times with all the great formations, with volcanic rocks, with changes in the level of land, and with fluctuations of the great American lakes. In one of his earlier papers, communicated to the Geological Society of London, he described the glacial phenomena of the central regions of North America, and attributed the deposits of the great plain to the action of floating ice. In later papers he gave accounts of the remarkable evidences of glaciation in British Columbia, and of the shore-lines and terraces which extend from the present sea-level up to a height of more than 5000 feet. He then maintained the marine origin of the drifts of the western plains, but stated his opinion without dogmatism, or, as he puts it (in the British Association Handbook of Canada), "under all reserve and subject to further inquiry."

Many of his geological observations were embodied in his official reports, commencing with a general description of the Tertiary Lignite formation which overlaps the Cretaceous strata of the Red River—a report prepared for the British North American Boundary Commission. On the Geological Survey his work lay principally in British Columbia and the North-West Territory. The economic resources necessarily occupied much attention, and the mines and minerals, as well as the more purely scientific problems, were investigated as fully as possible in Vancouver Island, Queen Charlotte's Island, the Yukon territory, and in all parts of British Columbia. He contributed also to journals and transactions of societies in the United States as well as in Canada.

In later years his time was so largely occupied with administrative work, and in the preparation of his annual reports of the progress of the Geological Survey in Canada, that he had little time for recreation. The full value of his work has hardly as yet been appreciated, but there is no doubt that his name will stand in the forefront among Canadian geologists. It is already written permanently in Dawson city, of gold-bearing fame, in recognition of his able researches in that region.

In 1891 he was elected a Fellow of the Royal Society of London, and in the same year he was appointed one of H.M. Behring Sea Commissioners. During the inquiry connected with this Commission he made personal observations on the natural history of seals, and his services were officially recognised by his being made C.M.G. In 1891 also he was awarded the Bigsby Medal by the Council of the Geological Society of London, in appreciation of the value of his researches into the geological structure of Canada. In 1893 he was elected president of the Royal Society of Canada, and in 1896 he was chosen president of Section C at the Toronto meeting of the British Association.

He died on March 2 after a brief illness.

NOTES.

TWO letters which have passed between Sir William Anson and Lord George Hamilton, with reference to the recent dismissals at Coopers Hill College, appeared in Wednesday's *Times*. Sir William Anson stated briefly the chief points upon which the request for an inquiry into the case is based. Accepting the decision that some change in the course of studies is necessary, it is urged that (1) the men affected by the proposed changes should have had an opportunity of a hearing when the president recast the course of studies, if only to see whether they would be willing to adapt themselves to the new conditions; (2) when the Board of Visitors considered, and in the main adopted, Colonel Ottley's recommendations, it does not seem to have been suggested to them that the teaching staff had not been consulted, or that they might have been consulted with advantage, or, at any rate, that the gentlemen whose dismissals were in contemplation had a right to be heard; (3) many persons eminent in science have expressed a strong opinion that the proposed dismissals will act injuriously on the scientific education of the country. In reply to Sir William Anson, Lord George Hamilton states that he has already taken steps to meet some of the complaints, and to put the teaching staff of the College upon a better footing. Upon his request the Board of Visitors have stated their readiness to meet to hear at once what the members of the teaching staff affected by the changes may wish to urge against them. In conclusion, Lord George Hamilton acknowledges that the channels of communication between those actually teaching and those in authority over the teachers—viz., the president and visitors—should be widened and quickened, and that a divergence of opinion such as has been revealed is detrimental, if not fatal, to harmonious co-operation. He adds, "I therefore propose to ask the Universities of Oxford, Cambridge and London to each nominate a visitor to be an addition to the present board. I shall ask the board, when so reconstituted, to appoint a committee, including the above, to inquire and report upon the working, discipline and constitution of the College, and the relations of the visitors, president and teaching staff."

THE Croonian Lecture of the Royal Society will be delivered on March 21 by Prof. C. Lloyd Morgan, F.R.S., on "Studies in Visual Sensation."

PROF. J. J. THOMSON, F.R.S., has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of nine persons of "distinguished eminence in science, literature, the arts, or for public services."

PROF. VON WETTSTEIN has been elected president of the Zoological-Botanical Society of Vienna.

THE Imperial Academy of Sciences of Vienna has inaugurated a botanical exploration of southern Brazil during the present year, under the leadership of Prof. von Wettstein and Prof. V. Schiffner.

WE learn from *Science* that the expedition sent by the U.S. Naval Observatory to observe the forthcoming solar eclipse was expected to leave San Francisco for Manila on February 16. From Manila it will be transported to Sumatra by a U.S. warship, and headquarters will be established at Padang about a month before the occurrence of the eclipse. The party includes Prof. Skinner, of the U.S. Naval Observatory, Prof. Barnard, of the Yerkes Observatory, Dr. Mitchell, of Columbia University, Dr. Humphreys, of the University of Virginia, and Mr. Jewell, of the Johns Hopkins University.

THE death is announced of Mr. John Hopwood Blake, F.G.S. Trained as an engineer under Brereton, he became an associate member of the Institution of Civil Engineers. In 1868 he joined the staff of the Geological Survey, and did much field-work in Somerset, in Norfolk and Suffolk, and latterly in Berkshire, Buckinghamshire and Oxfordshire. He was the author of memoirs on the geology of Yarmouth and Lowestoft, and of East Dereham, and had in preparation memoirs on the geology of Reading and on the water supply of Berkshire. Though slow as a worker and diffident in expressing his opinions, the work which he accomplished was performed with much enthusiasm and with the most painstaking care and precision. He died at Oxford on March 5, of angina pectoris, at the age of fifty-seven.

AT the Pan-American Medical Congress, which met recently at Havana, the board which has been engaged in the investigation of yellow fever, consisting of Drs. Reed, Carroll and Agramonte, made a report. According to Press reports it was stated that two of the main conclusions were that the specific cause of the disease is unknown, and that it can be carried only by mosquitoes. The fever can be produced by a subcutaneous injection of blood from a patient who must have had the disease for not more than two days. Mosquitoes must also bite the patient during the first two days of his illness or they cannot transmit the disease. The board kept an infected mosquito for fifty-one days, when it was allowed to bite a person, who contracted the disease. The board differs from Dr. Finlay in that the latter holds that more than one kind of mosquito can convey yellow fever. The board says there is only one kind that can do so. Dr. Finlay also says that a mosquito can transmit the disease the fourth or fifth day after biting a patient, while the board says that twelve days must intervene. The board reported that non-immunes were allowed to sleep in infected clothing and bedding, but none contracted the disease. Dr. Wilde, of the Argentine Republic, proposed the creation of an international yellow fever board to study means of exterminating the disease.

THE Royal Irish Academy has this year taken a step, after prolonged consideration, which will, it is hoped, still further establish its position in Ireland, and in the world of science and letters in general. It has adopted the principle of the bye-laws of the Royal Society of London, respecting the mode of election of members; the council is now empowered to select a number of persons, not exceeding twelve, in each year, from the list of candidates for membership proposed, and to recommend these to the body of members for election. The members may, at the single annual meeting at which elections now take place, substitute the name of any candidate already proposed for that of any candidate selected by the council; but the number of candidates elected must not be greater than that fixed by the council for that particular year. Changes have been also made in the bye-laws so as to provide for the more frequent introduction of new blood into the council. The position of the Royal Irish Academy becomes at the same time defined in relation to the other great medium of scientific publication and intercourse in Dublin, the Royal Dublin Society. While the latter, by its objects and foundation, must be to a large extent a popular institution, performing its important public functions and scientific work by the support of an extensive body of members, the Royal Irish Academy is able, on the other hand, to maintain its membership as a distinction, and to attract to itself, by this circumstance, those who are mainly concerned with the furtherance of research. A large number of its members are naturally also members of the Royal Dublin Society, and thus enjoy the advantages offered by the publication-committees of both societies. With these two bodies in session, and with the *Irish Naturalist* as a medium for current notes, scientific work in Ireland need not wait long before receiving recognition and discussion.

A REPORT of a second lecture on wireless telegraphy, delivered by Prof. Braun at Strassburg, has been received. The first lecture was referred to in our issue of February 21 (p. 403), in which it was stated that we could not gather whether Prof. Braun had succeeded in obtaining a satisfactory separation of messages received at the same time from different sources. From the present lecture it appears that this difficulty has been overcome in Prof. Braun's system, as in Marconi's and Slaby's, by the use of syntony, which has been utilised, not only to separate different messages, but to augment the effect of the waves received in any particular message. No actual result of long distance trials is given in the report before us, but it is natural to suppose that Prof. Braun's system will succeed in this respect as have the other competing systems. It is interesting to note that all experimenters have been led to this method of separating messages; when wireless telegraphy first attracted attention it was suggested that messages might be confined to their particular destination either by the use of reflectors or by careful tuning of transmitter and receiver. Apparently only the second of these has proved practical; no doubt the long wave-length of the vibrations used have proved fatal to the satisfactory use of reflectors.

THE Board of Trade could not well have arrived at a more satisfactory decision in the conference which was held last week with reference to the proposal to reduce the charge for electric lighting by putting a maximum limit of 6*d.*, instead of 8*d.*, per unit in the provisional orders before Parliament this session. The proposal, which emanated from the Board of Trade, was supported by the London County Council but opposed by several influential electrical bodies, including the Institution of Electrical Engineers and the electrical section of the London Chamber of Commerce, on the ground that it would have the effect of discouraging electric lighting in small country places where the population was scattered. It was urged by Colonel Crompton, on behalf of the Institution of Electrical Engineers, that the advantages to be gained by reducing the maximum in every district would be outweighed by the disadvantage of preventing the spread of electricity all over the country. This is, however, no reason why the dwellers in towns should pay highly that their brethren in the country may enjoy the benefit of electric light, and the obvious solution is that the maximum price should be regulated by the circumstances of the case. This is the solution adopted by the Board; they would fix, said Sir Courtenay Boyle, a normal maximum of 7*d.* a unit, but in the populous districts they would endeavour to make this 6*d.*; in special cases an 8*d.* maximum would be allowed if the undertakers were able to show sufficient cause.

SEVERAL correspondents have written to us with reference to falls of snow or ice crystals such as have been mentioned already (pp. 420, 441). Prof. G. H. Bryan states that a fall of snow stars occurred at Edgbaston, Birmingham, on January 6, and a similar fall, in which the stars were somewhat larger, happened at Bangor on February 15. "In the latter case," he adds, "the crystals which fell in the morning were not sufficient in number to form a coating on the ground, but many of them remained unmelted during the afternoon in shady corners. A few days later isolated stars were again falling, and this time the rays were larger and more feathery." Dr. Abbot noticed a fall of snow crystals at Tunbridge Wells in February, and in connection with the subject he asks whether such crystals should be considered as (1) skeleton crystals, (2) twins, or (3) aggregates of very small hexagons. He remarks:—"What seems to me the most interesting question is the regularity of the angles and distances of the secondary branches; and if we are dealing with skeleton forms, are not ice crystals unique in having these?" Another correspondent says that during a fall of snow crystals at Newcastle at the end of January or beginning of February last some of the crystals were about a quarter of an inch in diameter, and the outline was nearly circular.

SIR COURTENAY BOYLE objects, in the March number of *Macmillan's Magazine*, to many words in common use in science. His objections are partly etymological and partly to the vagueness of connotation of the words. Pliocene, miocene and phonolite are incorrectly formed; and the first two, together with palæozoic, mesozoic, kainozoic, jurassic and triassic are condemned because they are purely relative terms. Electron is objected to because there is sometimes a doubt whether it signifies a minute corpuscle having an electric charge or an electric charge without the corpuscle. Kion and autokion are suggested as preferable to the unsatisfactory words motor and the hybrid automotor.

THE U.S. *Monthly Weather Review* for November, 1900 (the last received) contains an interesting note of lightning from a cloudless sky, by Mr. C. E. Ashcraft, jun., of the Weather Bureau, Dominica. The phenomenon seems to be regarded in the States as one of rare occurrence, but in the West Indies it is frequently observed. The appearance of the flashes is that of sheet-lightning, and they do not seem to be confined to any particular quarter of the sky. The author considers that the theory of the exchange of electricities between vertical currents of air is a plausible explanation, as the phenomenon has always been observed in the evening, usually between seven and nine o'clock, at which time the colder currents of air are descending and setting up a vertical circulation, with steep gradients, and it is also at this time that the maximum electrification of the air occurs. Sometimes the sky is not absolutely clear, a few clouds hanging over the mountains to the east of the station, but the lightning will be seen far out to sea, where not the least vestige of cloud is visible. The flashes have been observed more frequently during the hurricane season. The phenomenon does not appear to be peculiar to the region of Dominica alone, but is said to have been observed in other parts of the tropics.

A NOVEL marine torch, in which acetylene gas is the illuminant, and of special design to ensure immediate ignition on being plunged into water, is described in *Fielden's Magazine*. The torch, it is stated, "simply consists of a plain cylinder of metal, sizes varying from 3 to 8 inches in diameter and from 1 to 5 feet in length. The cylinder, which is sealed at each end, contains in a wire basket a quantity of carbide of calcium and it also contains an air chamber to ensure sufficient buoyancy. At the head of the cylinder a number of burners is arranged adjacent to which is a small chamber containing calcium phosphide, which on contact with water generates phosphuretted hydrogen, ignites and also lights up the acetylene as it issues." The torch, which has no mechanism, is automatic throughout, the only precaution necessary before plunging into water being the removal of a protecting strip of metal by pulling a ring. The illuminating power of the torch can be gathered from the fact that a six-inch torch burns from an hour to an hour and a half with a candle-power of 2000 and a flame 12 inches high, and other torches which are rechargeable will burn from half an hour to ten hours according to size.

A FEW interesting instances of the application of physical instruments to the study of disease are given by Mr. Paget in a short review of the chief events in medicine and surgery between 1800 and 1850, in the *Middlesex Hospital Journal*. The chief influences which caused the great advance in the last ten years of that half century are stated by him to have been, first, the constant and general use of the microscope, both in physiology and pathology. Men left off speaking of tumours as "strange distempered masses"; they set to work to learn their minute

structure, and to interpret from it the clinical facts of each case. Next, the study of fevers, especially Sir William Jenner's observations on the essential difference between typhus and typhoid, and the improved treatment of fevers that was taught and practised by Graves of Dublin; he who said that he desired for an epitaph these words, "He fed fevers." Then, the invention of the ophthalmoscope by Helmholtz and the laryngoscope by Garcia, and the rise of special departments in hospital teaching, and of special work in practice. Next, the exact use of electricity in the diagnosis and treatment of nerve diseases, especially the work of Duchenne. The use of the thermometer followed, not invented all at once like the stethoscope, but very slowly established by years of work and millions of observations, especially the work of Wunderlich. Then the abolition of the old rough-and-ready methods of medical treatment, of useless bleeding and purging and low diet, and shameful abuse of mercury; and the knowledge of the selective action of drugs, especially the physiological study of such drugs as strychnine, curari, atropin and digitalis. Last of all, and best of all, the discovery of anæsthetics.

THE report of the Decimal Association records the progress made in the provision of instruction in the metric system of weights and measures, and the adoption of the system. By an article introduced into the code of elementary schools in 1900, instruction in the principles of the metric system, and in the advantages to be gained from uniformity in the method of forming multiples and submultiples of the unit, is made obligatory in the upper standards. Negotiations are in progress for bringing about a conference in Paris of official delegates and others, representing Great Britain, the United States and Russia, in favour of the adoption of the metric weights and measures in those countries. If this conference be held it will doubtless have important results. Active steps continue to be taken in the United States, and a bill for the introduction of the metric weights and measures in the State Departments is now before congress at Washington, and has been reported on favourably by the committee on coinage, weights and measures. The growth of public opinion in this country in favour of the metric weights and measures has attracted much attention in the United States, and has given an impetus to the movement there. In Canada, the Government are said to be seriously considering the adoption of the metric weights and measures, and several encouraging communications have been received by the Decimal Association from residents in that country. In Russia there is a growing disposition on the part of the Government to adopt the metric system, and there are good grounds for believing that an important step will be taken in that country shortly. In July last a report was issued by the Foreign Office which contained the replies of Her late Majesty's representatives in Europe to a circular addressed to them by the Marquis of Salisbury, asking for information as to the actual experience of nations which had adopted the metric system. The replies showed that in all cases the change was made without much difficulty, that there had never been any desire to return to the former system in use, and that the adoption of the metric system had assisted in the development of the trade of the countries which had adopted it. The second part of this report has just been published, and bears out these conclusions.

A SIMPLE elementary exposition of the principles of thermodynamics treated by means of the familiar p, v diagram is given by Mr. Robert H. Thurston in the *Journal* of the Franklin Institute, under the title "Elementary Graphics and Geometry of Thermodynamics."

IN the *Rendiconto* of the Naples Academy (January), Prof. Domenico de Francesco discusses certain problems in the dynamics of pseudospherical space. In a previous memoir the author gave an investigation of "motion under no forces" for such space, and he here interprets for the same kind of space the differential equations which in ordinary space represent motion about a fixed point under arbitrary forces.

IN the ordinary theory of elasticity it is proved that when a body occupying a simply connected region is not acted on by either surface tractions or bodily forces the strain vanishes at every point of the interior. Nevertheless, bodies may exist in which internal tensions act; for example, we may imagine a split ring the ends of which do not meet, and suppose these ends brought into contact and welded together. In the *Atti dei Lincei*, x. 3, Signor G. Weingarten points out that in all such cases surfaces must exist at which the displacements are discontinuous, and he discusses the properties of such surfaces. The subject is an interesting one, but the paper is only a short note.

IN the *Journal* of the Franklin Institute, Mr. John Price Jackson discusses the use of electricity for coal mining. Electricity may be economically used for lighting, hoisting purposes, pumping, cutting, drilling, running fans, operating breakers or washers, propelling bucket or belt-lifts, driving repair shop apparatus, &c. The question as to whether any or all of these applications shall be used is dependent directly upon local conditions. If a system of mines owned by one company are supplied from a central power-house, it is clearly possible to entirely do without local steam plants at the individual mines. Such an arrangement has several advantages in the matter of economy of fuel, the very great economy in repairs and a still further economy in working speed efficiency.

Science Abstracts always contains statements of results of interest to all students of science, as well as descriptions of work of special value to those engaged in work in physics and electrical engineering. To the latter the periodical is invaluable, and it should find a permanent place in the library of every Technical Institute and School of Science, as well as in educational institutions of higher rank. Many subjects are described in the abstracts, which are concise, well arranged, and of real importance to workers in all branches of physical science. There is no better way of creating an interest in scientific work and arousing a spirit of emulation than by making students familiar with the progress of scientific knowledge.

THE *Irish Naturalist* for March contains an excellent account of the natural history of that comparatively rare visitor to the British coasts, the grey phalarope, by Mr. C. J. Patten.

IN the *Entomologist* for March, Mr. W. L. Distant describes two new species from West Africa of that remarkable genus of Heteroptera known as Pephricus, the members of which so curiously resemble crumpled and broken leaves. The genus is of especial interesting as being one of the first in which "mimicry" was noticed, Sparman, who discovered the type species in 1775, mentioning his surprise on observing signs of active life in what he had taken for a dead leaf gnawed by caterpillars.

A HIGHLY suggestive and thoughtful paper on the question of the arboreal ancestry of marsupials and the mutual relations of the mammalian subclasses appears in the February number of the *American Naturalist*, by Mr. B. A. Bensley, who is now in this country studying marsupial ancestry. Taking as a text Dollo's view that marsupials were originally arboreal, that, on account of their foot-structure, they could not have been ancestors of placentals, and that they themselves are degenerate placentals, Mr. Bensley contrasts this with Huxley's scheme of mammalian evolution. According to the latter the Prototheria, which became specialised into the modern monotremes, gave

rise to the Metatheria, whose specialised representatives are the marsupials; while the Eutheria, specialised into modern placentals, are likewise an offshoot from the Metatheria. This phylogeny, thinks the author, is the most probable of all. It is urged that the imperfect placenta of the bandicoots, instead of being, as considered by Mr. Hill, vestigial, may be an instance of parallelism, and that in marsupials generally the allantois failed to form a placental connection. Owing to the antiquity of both placentals and marsupials, the arboreal character of the feet of the modern forms of the latter is of little importance. Further, it is considered that too much importance has been assigned to the characters distinguishing monotremes from other mammals; fœtal marsupials showing a monotreme type of coracoid, while it is probable that in the long run it will be found impossible to maintain the essential dissimilarity between the milk-glands of monotremes and those of other mammals.

ANOTHER paper in the same issue of the *American Naturalist*, by Mr. A. E. Ortman, deals with the subject of the geographical distribution of animals and plants, its title being the "Theories of the Origin of the Antarctic Faunas and Floras." Sir Joseph Hooker first, and the late Dr. L. Rütimeyer second, are credited with being the pioneers of the idea of the essential unity of the southern faunas. Rütimeyer, indeed, distinctly states that "we should take a part of the present faunas of South America, South Africa and Australia for remnants of an old fauna that spread over a large extent of the Antarctic continent, and that this Antarctic continent was the centre of origin of a peculiar Antarctic fauna." Here it may be appropriately mentioned that Dr. Stejneger, in a paper in the same journal, feeling, like many other writers, the urgent want of a word denoting both fauna and flora collectively, proposes the term "Biota" to fill the gap. If this were adopted, he adds, "*biotic* would then signify 'pertaining to or treating of a biota,' as, a biotic publication, a biotic region."

IN continuation of his earlier researches, Dr. Carl Sapper contributes a paper on the ethnography of southern Central America to the February number of *Petermann's Mitteilungen*. The paper gives an account of the languages of the region, with a map showing their distribution in 1899, and a comparative review of the civilisations of the different Indian tribes.

DR. EMIL SCHLAGINTWEIT returns to the question of the name of the highest mountain in the world in an article in the current number of *Petermann's Mitteilungen*. After discussing specially the Tibetan names Chomo Kankar and Tsering chenga, strictly Jomo gangs dkar and Thse ring mched lnga, Dr. Schlagintweit reasserts his former decision in favour of the name *Gaurisankar-Everest*.

THE *Verhandlungen* of the Berlin *Gesellschaft für Erdkunde* contains a paper on the geological history of the North German plain, by Prof. Wahnschaffe. An excellent summary is given of recent additions to our knowledge of the glacial phenomena of this region, especially those derived from deep borings. The *Zeitschrift* of the same society contains two important papers, one on the country and people of north-eastern Tibet, by Dr. K. Futterer, and a discussion of Dr. S. Passarge's observations of atmospheric pressure and temperature in the Lake Ngami region as applied to the determination of heights, by Herr G. von Elsner.

THE report of the Danish Meteorological Institute on the ice of the Arctic seas during 1900 has just been issued. With the support of the Seventh International Geographical Congress the Institute has been enabled to make this report fuller than in former years; not only is full information given from the Atlantic-Arctic waters, but a number of observations from the Bering and Beaufort Seas. The general features during the season were—great masses of ice in the north-west part of Barents Sea and round Spitsbergen, considerable masses of ice in the Kara Sea, less ice than in a normal year between Franz Josef Land and Novaya Zemlya and under the east coast of Greenland, normal conditions off south-west Greenland, and particularly favourable conditions off Labrador and in Baffin's Bay.

In the third part of his "Geology of the Boston Basin," Mr. W. O. Crosby deals with "The Blue Hills Complex" (*Occasional Papers*, Boston Soc. Nat. Hist., 1900). This complex is the area of granitic rocks and associated Cambrian strata in eastern Massachusetts, which includes the Blue Hills and the country eastwards to Quincy and the northern parts of Braintree and Weymouth. In this region is the famous quarry which yielded *Paradoxides Harlani* of the Middle Cambrian, but the Lower Cambrian with *Olenellus* is likewise represented. No recognisable trace of the floor upon which the Cambrian strata were deposited has been discovered, but that Upper Cambrian or Potsdam strata exist, or formerly existed, in the region is evidenced by fossiliferous pebbles in the Carboniferous rocks, which, together with drift deposits, occupy much of the ground. The Cambrian strata were strongly folded and invaded by great bodies of igneous rocks not later than Devonian times. All these rocks and the effects of metamorphism are fully described and illustrated. The author also discusses the relations of the Blue Hills complex to the peneplains of eastern Massachusetts, and to the Glacial phenomena of the area. The palæontology of the Cambrian strata is dealt with by Mr. A. W. Grabau, and the leading fossils are figured.

A NEW part of the revised second edition of Prof. Arnold Lang's "Lehrbuch der vergleichenden Anatomie der wirbellosen Thiere," dealing with the Protozoa, has been received from the publisher, Mr. Gustav Fischer, Jena. The book has been completely revised and partly rewritten.

THE *Monist* for January contains the translation of an address, by Prof. Ludwig Boltzmann, on "The Recent Development of Method in Theoretical Physics." This address was originally delivered at the congress of the Gesellschaft deutscher Naturforscher und Aerzte in Munich in September 1899.

A NEW meteorological journal has been established under the title *Climate*, with Mr. N. A. Demchinsky as editor. The periodical will appear twice a month, and all its contents will be in four languages—Russian, German, French and English. The chief object is to apply to weather prediction Mr. Demchinsky's theory that the moon is the chief factor in meteorological changes.

A LIST of the birds of the Bristol district is given in the volume of *Proceedings* of the Bristol Naturalists' Society (vol. ix. part 2) just published. Other papers are on a Rhætic section at Redland—a suburb of Bristol, by Mr. W. H. Wickes, with additional observations on the beds, by Mr. J. Parsons, and on Triassic deposits at Emborough, by Prof. Lloyd Morgan, F.R.S., and Mr. S. H. Reynolds.

THE second part of the report on a bathymetrical survey of the fresh-water lochs of Scotland, by Sir John Murray, K.C.B., F.R.S., and the late Mr. Fred P. Pullar, appears in the March number of the *Geographical Journal*. An account of the first part of the survey was given in NATURE of May 17, 1900 (vol. lxii. p. 65). The second part treats of the remaining lochs of the drainage basin of the Forth, viz., Loch Chon, with Lochan Dubh, Loch Ard, and Lake of Mentieth in Perthshire, and Loch Leven in Kinross-shire. The same number of the *Journal* contains a report of the special meeting held to commemorate the progress of geographical discovery during the Victorian reign.

THE general appendix to the annual report of the Smithsonian Institution for 1898, which has just been received, consists of

reprints and translations of thirty-six papers of wide scientific interest. Many branches of science are represented by the papers, and the whole collection forms a most interesting and valuable survey of subjects prominently before the scientific world in 1898. Limitations of space prevent us from giving a list of the papers reprinted from various reviews and scientific periodicals, but we are glad to direct attention to the following translations:—Recent progress accomplished by aid of photography in the study of the lunar surface, from a paper by MM. Loewy and Puiseux; the Le Sage theory of gravitation, translated from a paper by M. Prevost, with introductory note by Dr. S. P. Langley; the extreme infra-red radiations, by Dr. C. E. Guillaume; the perception of light and colour, by M. G. Lechalas; progress in colour photography, by M. G. H. Niewenglowski; oceanography, by M. J. Thoulet; the relation of plant physiology to the other sciences, by Dr. Julius Wiesner; *Pithecanthropus erectus*—a form from the ancestral stock of mankind, by Dr. E. Dubois; our present knowledge of the origin of man, by Prof. E. Haeckel; the laws of orientation among animals, by Captain G. Reynaud; the theory of energy and the living world—the physiology of alimentation, by M. A. Dastre; a sketch of Babylonian society, by Herr F. E. Peiser; the excavations of Carthage, by M. P. Berger; the origin of African civilisations, by Dr. L. Frobenius; dogs and savages, by Dr. B. Langkavel; the life and works of Brown-Séquard, by M. Berthelot. It will be seen from this list that the volume contains no less than sixteen translations of papers on important subjects. By publishing these translations, with the reprints, the Smithsonian Institution records the progress of scientific thought in a most serviceable way, and enlarges the outlook of men of science who do not read German and French with facility.

THE discovery of the organo-metallic compounds nearly half a century ago, by Frankland, opened up a wide field of organic synthesis, which has for some time been regarded as exhausted. It has, however, been recently shown by M. Grignard that many syntheses which are effected only with difficulty with the zinc alkyls can be carried out with great ease with magnesium compounds. In the current number of the *Comptes rendus* M. Grignard gives a *résumé* of his work in this direction, together with a theoretical study of the reaction. By the action of magnesium upon an alkyl iodide the compound RMgI is first formed, and this condenses readily with aldehydes and ketones, without there being any necessity to isolate the organo-metallic compound, giving ultimately secondary or tertiary alcohols, the yields being as high as 50 per cent.

THE additions to the Zoological Society's Gardens during the past week include a Pardine Genet (*Genetta pardina*) from West Africa, presented by Lady Moor; a Common Otter (*Lutra vulgaris*), British, presented by Mr. W. Radcliffe Saunders; a Yak (*Poephagus grunniens*) from Tibet, presented by Mr. A. E. Pitt-Rivers; a Blue Whistling Thrush (*Myiophoneus coeruleus*) from the Himalayas, a Jerdon's Green Bulbul (*Chloropsis jerdoni*), a Black-crested Yellow Bulbul (*Otocampsa flaviventris*), two Blyth's Hill Partridges (*Arboricula rufigularis*), an Indian Green Barbet (*Thereiceryx zeylonicus*) from India, a Great Barbet (*Megalaema virens*) from China, presented by Mr. E. W. Harper; a Grey-backed White-eye (*Zosterops dorsalis*) from Australia, presented by Mr. D. Seth-Smith; a Buzzard (*Buteo vulgaris*), European, presented by Mr. J. A. Harvie Brown; a Black Kite (*Milvus migrans*), European, presented by Mr. H. Wreford; a Red Kangaroo (*Macropus rufus*) from Australia, two Striated Jay Thrushes (*Grammatoptila striata*) from the Himalayas, two Rufous-chinned Laughing Thrushes (*Ianthocincla rufigularis*), a Rat Snake (*Zamenis mucosus*) from India, deposited; a Black-faced Kangaroo (*Macropus melanops*) from Tasmania, a Barraband's Parrakeet (*Polytelis barrabandi*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

NOVA PERSEI.—The position of the star, as given by the meridian circle at Greenwich, is

	h.	m.	s.	
R.A. =	3	24	28·21	(1901).
Decl. =	+ 43°	33′	54″·8	

During the fortnight since its discovery the star has undergone a remarkable series of changes both in brightness and spectrum.

Variation in Brightness.

	Mag.		Mag.		Mag.
Feb. 22	2·7	Feb 28	2·1	March 6	2·9
23	0·10	March 1	2·2	7	3·0
24	0·65	2	2·3	8	3·2
25	1·0	3	2·4	9	3·5
26	1·1	4	2·6	10	3·7
27	1·5–2·1 ...	5	2·7	11	3·9

In the current issue of *Comptes rendus* (vol. cxxxii. pp. 535–538) M. H. Deslandres describes his observations on the spectrum made with the spectroscope designed for line of sight measures at the Meudon Observatory. The photograph of the star's spectrum was obtained alongside a comparison showing the lines of iron, calcium, hydrogen, helium and air.

After noting the great breadth of the bright lines, he states that the middle of each band is displaced *towards the red* with respect to the terrestrial spectrum. The spectrum is similar to Nova Aurigæ, but the lines are broader. He then draws attention to the minute structure of the Hβ (F) line of hydrogen, which shows *three* maxima of brightness, the more refrangible component being the most intense. The other lines show similar structure, but not so clearly.

On the other hand, the calcium lines at H and K each show a fine, clear, dark line, the only sharp lines in the spectrum; both are displaced slightly towards the red M. Deslandres discusses the two explanations of the width of the lines, that of Doppler-Fizeau ascribing the appearance to motion, the other, suggested by the experiments of Humphrey and Mohler and Wilsing, indicating the cause to be the great pressure to which the gases are probably subjected. He concludes by ascribing the group of lines immediately less refrangible then Hβ to magnesium and asterium, but these have been traced by other observers to the most prominent enhanced lines of iron.

CO-OPERATION IN OBSERVING VARIABLE STARS.—*Circular* 53 of the Harvard College Observatory consists of an outline plan drawn up by the Director, Prof. E. C. Pickering, for enabling a systematic investigation of variable stars to be made by the cooperation of observers in various localities. This has been induced by the fact that the number of long-period variables is now so great that many of them are neglected.

In the case of variables of small range the difficulty is not so great, as the variation is in most cases regular, but many of the variables of long period appear to change irregularly, and continuous observations are required until the nature of the changes are known. Moreover, the range is, in many cases, so great that the errors of observation are not sufficient to affect seriously the form of the curve.

It is recommended that in the vicinity of each variable a series of about twelve comparison stars be selected, the brightest being slightly brighter than the variable at maximum, and the faintest fainter than the variable at minimum. The intermediate ones should gradually decrease in brightness with about half-a-magnitude differences.

The actual magnitudes of all such stars brighter than the *seventh* magnitude can be supplied from the meridian photometer records, and means are now being adopted for furnishing on a uniform scale the brightness of the faintest stars likely to be visible in any telescope. At least one observation of each star should be made every month.

For searching out comparison stars the excellent charts of Father Hagen are recommended for stars fainter than the ninth magnitude. For brighter ones copies have been made of the Bonn Durchmusterung charts, giving 3° square about each variable, and these will be supplied to experienced observers willing to co-operate in the work. A list of seventy-three variables for which these charts will soon be ready is furnished.

DIMENSIONS OF THE SATURNIAN SYSTEM.—Prof. T. J. J. See has recently completed a long series of measures of the

various planetary systems with the 26-inch refractor of the United States Naval Observatory at Washington. In the *Astronomische Nachrichten* (Bd. 154, Nos. 3686–7) he gives the details and results of the investigations of Saturn, including measures of the planet, rings, and the satellite Titan. He attributes much of the consistency of the values determined to the use of various colour screens placed between the eye and the telescope, which reduces or eliminates entirely the secondary spectrum produced by the objective, thereby enabling a much more sharply defined disc to be obtained.

In addition to his own recent measures, the author also brings together previous work on the subject from 1659. The following is a summary of the new determinations :—

		km.
External diameter of the outer ring ...	= 40″·304	278,768
Internal diameter of the outer ring, *or* External diameter of Cassini's division	= 34·787	240,610
Diameter of the centre of Encke's division	= 37·777	261,290
Width of Encke's division	= 0·107	740
Total width of the outer ring	= 2·758	19,076
Width of the outer part of the outer ring	= 1·237	8,556
Width of the inner part of the outer ring	= 1·414	9,780
Width of Cassini's division	= 0·418	2,891
External diameter of central ring ...	= 33·951	234,827
Internal diameter of central ring, *or* External diameter of dusky ring ...	= 25·952	179,501
Width of central ring	= 4·000	27,667
Internal diameter of dusky ring ...	= 20·582	142,359
Black space between Saturn's globe and dusky ring	= 1·567	10,838
Equatorial diameter of Saturn	= 17·448	120,682
Assumed oblateness of Saturn (H. Struve)	= 0·1013	
Polar diameter with this oblateness ...	= 15·681	108,457
Assumed mass of Saturn (Bessel) ...	= 1:3501·6	
Resulting mean density of planet ...	= 0·1234 = 0·679 that of water.	
Diameter of the satellite Titan ...	= 0·487	3,368

HYDROGEN IN AIR.

IN a recent number of the *Annales de Chimie et de Physique* (January, 1901), M. Armand Gautier, professor of chemistry at the École de Médicine, Paris, gives a connected account of his researches on the combustible gases of the atmosphere. These researches have occupied some years, they have been carried out with extraordinary care and completeness, and they have yielded results of very great interest both in regard to their main object and also in relation to incidental scientific questions.

The most striking fact elicited by M. Gautier is that pure air contains free hydrogen as a normal constituent to the extent of about two volumes in 10,000. This conclusion, taken in conjunction with the recent experiments of Profs. Liveing and Dewar (NATURE, December 20, 1900, p. 189), in which they record the isolation of a fraction of air containing 43 per cent. of hydrogen, which they actually exploded, seems to admit of no doubt.

Analytical Methods.—M. Gautier set himself to determine the character and amount of combustible gases in the atmosphere by aspirating a large volume of air through a train of absorbents. Nothing could be more obvious and simple in principle than such a method ; the difficulty of making it available for determining with any degree of certainty the character and quantity of very small amounts of combustible gases will, however, be thoroughly appreciated by chemists.

The first part of M. Gautier's memoir is devoted to a description of the preliminary work which was necessary for the selection and proper use of the absorbents. Beginning with carbon dioxide, he confirmed the previous observation of Boussingault and Eliot and Storer that carbon dioxide is very difficult to absorb from a large admixture of other gases. After circulating 90 litres of ordinary air during forty-eight hours through a tube 80 centimetres long and containing glass beads moistened with caustic potash solution of density 1·3, it was found that 10·7 c.c. per million of CO_2 remained unabsorbed. A satisfactory absorbent in respect both to rapidity and completeness was found in barium hydrate, either dissolved or simply moistened with water. This substance would, of course, also absorb other acid gases, such as H_2S, SO_2 and NO_2.

The desiccation of air by sulphuric acid was also shown to be incomplete ; a satisfactory agent was found in phosphoric oxide previously heated with oxygen at 260° C. to get rid of lower oxides.

For the absorption of minute quantities of carbon monoxide the ordinary reagents are ineffective and a new one was found in iodine pentoxide. Air containing 1/100,000th of the gas loses it completely and at once when passed over the pentoxide heated to 70° C. Carbon dioxide, oxygen, nitrogen, hydrogen, marsh gas have no action on the oxide at that temperature, and other more strongly reducing gases, such as alcohol vapour and benzene when much diluted are also without action. When carbon monoxide acts upon iodine pentoxide, iodine and carbon dioxide are produced ; the iodine is absorbed by a tube containing finely divided copper and the carbon dioxide by barium hydrate. The estimation of hydrogen and hydrocarbons is next dealt with. When a mixture of 50 c.c. of hydrogen with 235 litres of pure air was passed over heated oxide of copper the hydrogen was entirely burnt provided that a tube of 70 centimetres was employed. With a tube of 30 centimetres, only 70 per cent. of the hydrogen was burnt. When using shorter tubes in subsequent experiments the weight of water obtained had to be multiplied by a factor in order to give the effect of an "infinite" tube of copper oxide.

When diluted marsh gas is passed over heated copper oxide there is neither complete combustion nor equivalent combustion of the carbon and hydrogen, and here also the use of factors is necessary. The hydrogen burns in greater proportion than the carbon. With a diluted mixture of marsh gas and hydrogen it was found that the presence of the hydrogen facilitated the combustion of the hydrogen of the marsh gas but retarded that of the carbon. Admixture of the copper oxide with spongy platinum or with other metallic oxides did not improve the efficiency. It was found that the copper oxide, after continued heating to redness, gradually lost its power of oxidising, and after 1500 hours it was without effect upon hydrocarbons, and it only partially oxidised free hydrogen.

For a detailed description and drawing of the apparatus the original memoir must be consulted. The air was filtered from suspended impurities by filtration through glass wool, its carbon dioxide was then absorbed—and in this connection the author devised a special form of absorption tube which he strongly recommends—water was then absorbed and the air entered the combustion tube. The combustion tube was heated in a furnace of special construction, in which great uniformity of temperature could be maintained from end to end. Water and carbon dioxide formed by combustion were then absorbed, and the apparatus terminated in an aspirator, a "decanteur" and a meter. There were in all twenty-eight pieces in the train ; they were connected together by clamped india-rubber joints made from purified tubing, which experiment showed to be proof against diffusion.

The Air of Paris.—Beginning first with towns, M. Gautier examined the air in the region of the École de Médicine. The average ratio of carbon and hydrogen found corresponded pretty nearly to CH_4, but there was evidence at times of some more highly carburetted hydrocarbon being present, at others of free hydrogen.

There was no evidence of hydrocarbons of the ethylene or acetylene series being present.

The quantity of carbon monoxide found was extremely small, it averaged 2·11 volumes per million, but this included one very abnormally high instance. Neglecting this one instance the average of ·56 volume per million was obtained. The quantity of carbon monoxide varied in different places ; it increased in densely populated places. In a small room at the laboratory heated by an old-fashioned faience stove and illuminated for several hours by three gas jets 12·3 volumes were found. On the whole the quantity of CO and unsaturated hydrocarbons in town air may be said to be insignificant.

The Air of Forests.—The next experiments related to the air of forests, and the station fixed upon was a clearance in the middle of a wood at Lainville, 70 kilometres from Paris.

Here the proportion of carbon to hydrogen pointed distinctly to the presence of free hydrogen along with marsh gas. It did not seem probable that the hydrogen came directly from living vegetation, but it was possible that it might arise from decomposition going on in the soil, and it was therefore decided to make analyses in localities where this possible source would be removed to a large extent.

Mountain Air.—With the object just referred to, the next station selected was in the Pyrenees on the Pic Canigou, a barren mountain 2785 metres in height. The transport of the apparatus to this remote station required six porters and mules, and M. Gautier with his *préparateur* and one guide were left to make the best of a rock cabin amidst the snow, fires being suppressed in order to avoid contamination of the atmosphere.

Under these cheerless conditions a series of determinations was made which amply realised the anticipation that in the absence of vegetation and soil the proportion of marsh gas would diminish. The quantity found was 2·19 volumes per 100,000 as against 11·3 for the air of woods and 22·6 for the air of Paris.

The quantity of free hydrogen reached 17 parts per 100,000.

Sea Air.—M. Gautier now decided to get rid of vegetation altogether by going out to sea, and took up his station during the autumn equinox at the iron lighthouse of the Roches-Douvres, 40 kilometres from the coast of Brittany. He arrived after a series of north-west gales, and was, he says, altogether *très favorisé par les circonstances*. Analysis showed a fall in the proportion of carbon to 1/33 of what it was in mountain air, that is, to an almost negligible quantity. There was an increase in the amount of free hydrogen to 19·5 vols. per 100,000. It appears, therefore, that the air over the sea and at very high altitudes is nearly free from hydrocarbons, and that it contains two vols. in 10,000 of free hydrogen, a proportion, it will be observed, about two-thirds of that of the atmospheric carbonic acid.

Source of the Gases.—In the concluding section of his memoir, M. Gautier discusses in more detail the nature of the accessory combustible gases in the air and the origin of atmospheric hydrogen. He concludes that, subject to variations, the combustible gases of Paris air may be set down as follows, in volumes per 100,000:—Free hydrogen 19·4, methane 12·1, benzene vapour or analogous compounds 1·7, carbon monoxide and traces of olefines and acetylenes ·2.

It remains now only to show that the presence of hydrocarbons in air is in accordance with established geological facts, and that it is connected with the occurrence of the larger quantities of free hydrogen. M. Gautier points out that methane is exhaled from many soils, that it is the chief constituent of fire-damp, that it occurs with petroleum and is emitted by volcanoes, especially by mud volcanoes. Hydrogen often accompanies methane in these cases, and has been found in the fumerolles of Iceland and Tuscany. These outbursts are only extreme manifestations of actions which have been silently in continual progress for ages. The occurrence of hydrogen occluded in rocks has been pointed out by Fouqué and by Tilden. M. Gautier has himself greatly extended earlier researches. He finds that many specimens of granite treated with water at 280° C. or with dilute acids at 100°, yield a considerable volume of gas. Thus, in one case, a kilogramme of granite heated with diluted phosphoric acid gave the following volumes in c.c.:—H_2S 1·2, CO_2 272·6, C_2H_2 12·3, CH_4 trace, N_2 (rich in argon) 230·5, H_2 53.

It seems probable that when the igneous rocks were solidifying and their components crystallising, they included small quantities of the primitive earth materials which now form the subjacent zone, that is to say, sulphides, nitrides, argonides, heliides, hydrocarbons, carbides, fluorides, iodides, phosphides, arsenides, &c. These substances, by the action of water, aided or not by acids, gave rise to the observed gases. As to the hydrogen, M. Gautier is assured by experiments, which he does not now detail, that it comes from (*a*) the action of water at a red heat on ferrous compounds, (*b*) the destruction by heat of hydrocarbons formed previously by the action of water on metallic carbides, (*c*) in a less degree by the action of water at a red heat on certain nitrides.

Hydrocarbons come from the action of water on small quantities of metallic carbides, especially those of aluminium and iron, included in the rocks.

Many more details of geological and chemical interest are given by M. Gautier. He insists that it is not necessary to imagine that water penetrates to the molten material lying below the solid crust of the earth. It is sufficient for the water to reach the low layers of rock containing these small quantities of included raw materials. On the other hand, it is not to be supposed that the gaseous products of the action of water on the raw materials will all escape from the surface. Some of the gases will combine with the rocks, and some on reaching the region of oxygen will be oxidised; but others, including methane, the petroleum hydrocarbons, nitrogen and hydrogen, not readily oxidised except at high temperatures, will escape into the air.

M. Gautier deals briefly with the question as to whether the hydrogen will tend to accumulate in the upper regions of the atmosphere. Without committing himself to a definite opinion, he quotes the views of Dr. Johnstone Stoney as to the impossibility of the earth's gravitational attraction being sufficient to retain helium or hydrogen. If the view is accepted that some of the hydrogen molecules at the fringe of the atmosphere have a velocity outwards of 11,000 metres per second, their escape would be possible, and we should have to picture a continual flux of hydrogen from the earth's surface through the atmosphere into interstellar space.

It is interesting to note that Profs. Liveing and Dewar incline perhaps to a different view. They say "if the earth cannot retain hydrogen or originate it, then there must be a continued accession of hydrogen to the atmosphere (from interplanetary space), and we can hardly resist the conclusion that a similar transfer of other gases must also take place."

Whatever view be correct as to the source and retention of atmospheric hydrogen, there can be no longer any doubt not only of its presence but of its abundance, and the establishment of this fact marks an advance in knowledge highly important from many points of view. A. S.

SCIENTIFIC AGRICULTURE IN THE UNITED STATES.[1]

AGRICULTURAL experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories of the United States. Agricultural experiments have been begun in Alaska with the aid of national funds, and an experiment station is in operation in Hawaii under private auspices. In each of the States of Alabama, Connecticut, New Jersey and New York a separate station is maintained wholly or in part by State funds, and in Louisiana a station for sugar experiments is maintained partly by funds contributed by sugar planters. Excluding the branch stations established in the several States, the total number of stations in the United States is 54. Of these 52 received the appropriation provided for in the act of Congress above mentioned. The total income of the stations is about 1,143,334 dollars, of which 720,000 dollars was received from the National Government, the remainder, 423,334.93 dollars, coming from the following sources: State Governments, 240,300.20 dollars; individuals and communities, 12,100 dollars; fees for analyses of fertilisers, 75,294.42 dollars; sales of farm products, 69,312.60 dollars; miscellaneous, 26,327.71 dollars. In addition to this the Office of Experiment Stations has an appropriation of 40,000 dollars for the past fiscal year, including 10,000 dollars for the Alaskan investigation.

The stations employ 678 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows:—Directors, 71; chemists, 148; agriculturists, 68; experts in animal husbandry, 9; horticulturists, 77; farm foremen, 21; dairymen, 23; botanists, 52; entomologists, 48; veterinarians, 26; meteorologists, 17; biologists, 7; physicists, 7; geologists, 5; mycologists and bacteriologists, 20; irrigation engineers, 5; in charge of sub-stations, 16; secretaries and treasurers, 24; librarians, 9; and clerks, 43. There are also 48 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds and buildings, apiarists, herdsmen, &c. Three hundred and eight station officers do more or less teaching in the colleges with which the stations are connected.

During 1899 the stations published 445 annual reports and bulletins, containing 16,924 pages. Besides regular reports and bulletins, a number of the stations issued Press bulletins, which were widely reproduced in the agricultural and county papers.

In a recent report on the work and expenditures of the stations, Mr. A. C. True, the Director of the Experiment Station Office, makes the following general statements:—

The work of the stations during the past year has for the most part been along the same lines as heretofore, and in the

[1] Abridged from the *Experiment Station Record* (vol. xi. No. 9), published by the U. S. Department of Agriculture.

aggregate a large amount of useful work has been accomplished. By their own efforts and with the aid of the colleges of agriculture and the State boards or commissioners of agriculture, the stations are bringing their work home more closely to the farmers through publications, farmers' institutes, agricultural associations, home reading courses, and the Press. It is becoming evident that farm practice in the United States is being materially affected by the work of the stations, and they are more and more relied upon by our progressive farmers for advice and assistance.

The wisdom of Congress in making the Hatch fund a research fund is every year becoming more apparent. This Department is therefore disposed to more strongly insist on a strict interpretation of this act in this direction, and to hold that it is not only in accordance with the obligation, but also to the interest of the States, to devote the Hatch fund to investigations in agriculture and to supplement this fund as far as may be necessary to promote the interests of agriculture in other lines.

The movement for the improvement of courses of agriculture in the colleges with which the stations are connected is steadily growing. The past year has witnessed many changes for the better as regards specialisation of the work of instruction and the development of courses suited to the varied needs of students. More than ever before, the colleges are reaching out beyond their class rooms and are carrying useful instruction to the farmers through farmers' institutes, correspondence courses, and other forms of so-called university extension. As this outside work becomes better organised it is more apparent that it belongs to the college rather than the station.

As the work of both college and station grows in extent and complexity, it becomes more apparent that in order to perform the most efficient service the station should be organised strictly as a separate department of the institution with which it is connected, and that it should have an organisation so compact that its work may proceed in accordance with a schedule carefully planned and energetically administered. To secure this end, experience shows that it is quite desirable that the station should have a competent executive officer, who can devote his time very largely to planning and directing its operations, managing its general business, and representing its interests before the public. It is encouraging to observe that in several States during the past year these considerations have led to the more complete separation of the business of the station from the general business of the college, and to the appointment of a director of the station as a separate officer.

From the very first the stations in the United States have been largely engaged in the inspection of commercial fertilisers, and this work has been so efficiently and usefully conducted that from time to time additional inspection duties have been laid upon the stations. The movement for the establishment of different kinds of inspection service under authority of the National and State Governments is growing apace, and it is very important that the relations of this work to the other functions of the stations should be clearly understood. Soon after the establishment of the stations under the Hatch Act this Department ruled that the funds appropriated under this Act could not be legitimately applied to pay the expenses of the inspection and control of fertilisers. The same principle holds good with reference to other forms of inspection service demanded of the stations. While the methods and usefulness of inspection in any particular line are still problematical, it may be justifiable for a station to take up this work to a limited extent, but as soon as it becomes a matter of routine business the State should provide funds for its maintenance. If it seems expedient that any part of the inspection service should be performed by the station under State laws and at State expense, the matter should be so arranged as not in any way to interfere with the investigations of the station. It is a great mistake to divert the time and energy of a competent investigator to the toilsome routine work of inspection service.

The number and importance of the experiments which the stations are conducting in cooperation with practical farmers and horticulturists have greatly increased of late. Thousands of such experiments are now annually conducted in the United States. These range all the way from simple tests of varieties of plants to special experiments in the management of farm or horticultural crops, live stock, or particular operations, such as tobacco curing. It is coming to be more clearly recognised that the field operations in agriculture or horticulture conducted on the station farm need to be supplemented by similar work in a considerable number of localities in order to be of general usefulness to the State. By going into different localities, as the needs of its work demand, the station can make itself more useful to the State as a whole. Without doubt cooperative experiments need to be very carefully planned and thoroughly supervised to be successfully conducted, and their success depends on their quality rather than their number. It is encouraging to observe that more careful attention is being given to this important matter by station officers, and it is believed that this work may be made much more economical and useful than the permanent substations as ordinarily managed.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In consequence of the death of Sir John Conroy, a tutorial fellowship in chemistry and physics, to be held in conjunction with the Bedford Lectureship, is announced at Balliol College. The fellow elected will be expected to supervise the whole science teaching of the College and to give instruction in chemistry and elementary physics. Applications, with the names of three persons to whom reference may be made, must be sent to the Master on or before April 18.

Profs. E. A. Minchin and A. Sedgwick have been appointed public examiners in zoology.

Scholarships in natural science are announced for June 18 at Merton College, New College, and non-collegiate students.

CAMBRIDGE.—The Smith's Prizes are awarded to Mr. G. H. Hardy and Mr. J. H. Jeans, of Trinity College. Mr. P. V. Bevan, of the same College, receives honourable mention. The prizemen were second and fourth wranglers respectively in 1898. Mr. Bevan was fourth wrangler in 1899.

Mr. L. Doncaster, of King's College, is nominated to the University table at the Naples Zoological Station.

Miss Meyer has presented to the Geological Museum the valuable collections made by her brother, the late Mr. C. J. A. Meyer.

THE senate of Glasgow University has resolved to confer the honorary degree of LL.D. upon Prof. A. W. Rücker, Sec. R.S., at the graduation ceremony on April 23.

THE council and senate of University College, Liverpool, has passed a resolution "that any measure dealing with the organisation and control of secondary education should provide for the direct representation of Universities and University colleges in the local authorities which such Bill may establish."

THE chair of natural philosophy in the University of Edinburgh will become vacant on April 29, in consequence of Prof. Tait's resignation. The patronage of the chair is vested in the curators. Applications, with relative testimonials, should be lodged with Mr. R. Herbert Johnston, secretary to the curators, at 4, Albyn Place, Edinburgh, on or before June 1.

THE annual general meeting of the Association of Technical Institutions, adjourned in consequence of the death of the Queen, will be held at the Fishmongers' Hall, London, on Tuesday, April 16, when the president, Sir Swire Smith, will take the chair and the president-elect, the Right Hon. Sir William Hart Dyke, M.P., will deliver an address.

FROM the ninth annual report of the Technical Instruction Committee of the City of Liverpool we derive the following facts as to valuable scientific instruction and work assisted by the committee. A course of four lectures was given on "Electric Vibrations," by Prof. O. J. Lodge, F.R.S., and a course of five lectures on "Oceanography," by Prof. Herdman, F.R.S. Both courses proved very successful in achieving the main object for which they were designed, viz., to bring before teachers of schools and classes some of the results of the progress of modern science, and to illustrate the methods and lines upon which this progress is proceeding. Admission to the courses was free to teachers of schools and classes in Liverpool. In 1900 the committee again renewed their grant (of 100*l.*) in aid of the scientific work carried on by the Lancashire Sea Fisheries Joint Committee. A permanent Sea Fisheries Laboratory in the Zoological Department of the University College, under the direction of Prof. Herdman, is partly supported by this grant; and trained assistants are constantly at work in this laboratory investigating fisheries' questions that may arise in

connection with the local industries. One of the rooms of the Zoological Museum at the University College of Liverpool is devoted to a permanent fisheries collection, illustrating the local fishing industries. The committee has thus proved that success attends the co-operation of the work of men of science in University Colleges with that of technical instruction, and their action should lead to the development of a similar policy in other cities.

SCIENTIFIC SERIALS.

Symons's Meteorological Magazine, February.—The pressure of the wind, by R. H. Curtis. In this paper the author deals with the wind-pressure from the point of view of the engineer and its effect upon structures, rather than from a purely meteorological standpoint. After the time of the collapse of the Tay Bridge, in December 1879, a good deal of attention was paid to this subject, and a committee was appointed to consider the question of wind force on railway structures. It estimated that the greatest pressure likely to be experienced over a large surface was 56 lbs. per square foot, but that, to ensure safety, bridges and similar structures ought to be built to withstand four times that pressure. This conclusion has probably led to an extravagant expenditure of money, as the records of improved and well-exposed anemometers have recently shown that this estimated pressure of 56 lbs. was greatly in excess of anything likely to be experienced. It is true that an Osler's pressure anemometer at Liverpool Observatory registered the extraordinary pressure of 90 lbs. on the square foot in March 1871. But this exaggerated record must have been due to a succession of impulses upon the pressure plate, as a wind force of less than 60 lbs. per square foot would, in all probability, have sufficed to carry away the anemometer itself. The author has paid much attention to this subject and will continue his interesting discussion.—Weather records at Slough, by Mr. R. Bentley. Instrumental observations were begun there by Sir William Herschel in the latter part of the eighteenth century. Mr. Bentley communicates classified rainfall values for 1874–1899, and has collected non-instrumental records of interesting phenomena in South Buckinghamshire from a very remote period.

American Journal of Science, February.—Apparent hysteresis in torsional magnetostriction and its relation to viscosity, by C. Barus. A differential method is employed, in which the two identical wires of iron or nickel to be compared are fastened coaxially one above the other, a mirror being attached between them. Accidental temperature effects are avoided by keeping the lower wire submerged in a tube of flowing water. A current can be sent either round or through the wire, so as to place the wire in either a longitudinal or circular field, the effect to be observed showing itself in a shifting of the fiducial zero. The phenomena are independent of the direction of the current and a larger angle of twist does not appear to magnify them. The results, which are somewhat complex, can be understood if magnetisation be regarded as a means of shaking up the molecular mechanism, and thus to produce temporary molecular instability or momentarily very low viscosity.—The dinosaurian genus Creosaurus, Marsh, by S. W. Williston. A description of a shoulder girdle and arm of a carnivorous dinosaur obtained from a deposit in the Freeze Out Mountains, Wyoming. The fossil is well differentiated from Allosaurus, although occurring with remains which may possibly belong to that genus.—The stereographic projection and its possibilities from a graphical standpoint, by S. L. Penfold. A continuation of a previous paper. The graphical methods are applied to some solutions of spherical triangles, in determining geographical distances, and to map projection.—On the melting point of gold, by L. Holborn and A. L. Day. These results have been already noted in the January number of *Wiedemann's Annalen*.—On some new mineral occurrences in Canada, by G. Chr. Hoffmann. The minerals described are lepidolite, newburyite, struvite, schorlomite, danalite, spodumene and uranophane.

Bulletin of the American Mathematical Society, February.—The seventh annual meeting of the Society was held in New York City, on December 28, 1900. Several important changes in the organisation of the Society were made, the membership of which has now reached the fine total of 357 names. Prof. F. N. Cole gives a brief recapitulation of advance since the foundation of the Society, and fully records the proceedings at the Christmas gathering. The titles of seventeen papers are given and abstracts of many of them are here printed. On some birational transformations of the Kummer surface into itself, by Dr. J. I. Hutchinson, is a paper read at the meeting. Another paper that was read is entitled "Theorems concerning positive definitions of finite assemblage and infinite assemblage," by C. J. Keyser. A third paper, by W. B. Ford, is entitled "Dini's method of showing the convergence of Fourier's series and of other allied developments." Short notice follows of Fehr's Application de la méthode vectorielle de Grassmann à la géométrie infinitésimale, by E. B. Wilson, and of the Annuaire pour l'An 1901, publié par le Bureau des Longitudes, by Prof. E. W. Brown. Notes and new publications as usual.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 21.—"An Investigation of the Spectra of Flames resulting from Operations in the Open-hearth and 'Basic' Bessemer Processes." By W. N. Hartley, F.R.S., Royal College of Science, Dublin, and Hugh Ramage, A.R.C.Sc.I., St. John's College, Cambridge.

Three papers on "Flame Spectra," by one of the authors, were published in the *Philosophical Transactions* for 1894. Parts I. and II., "Flame Spectra at High Temperatures," and Part III., "The Spectroscopic Phenomena and Thermochemistry of the Bessemer Process."

The spectroscopic results were quite different from those previously obtained by observing the "acid" process, as the continuous spectrum was much stronger. Many lines and bands new to the Bessemer flame spectra were observed.

Twenty-six plates of spectra were photographed. The spectra increase in intensity as the blow proceeds in the first stage, and this can only result from a corresponding increase in the temperature of the bath of metal and of the flame.

Considerable difficulty was experienced in the identification of some of the lines and bands; some were due to uncommon elements, and others were relatively much stronger than a study of the oxyhydrogen flame and other spectra of the same metals had hitherto shown.

Conclusions.

(1) Line spectra are not observed in the open-hearth furnace. This is attributed mainly to the fact that the atmosphere of the furnace is oxidising, and under these conditions, as Gouy has shown (*Phil. Mag.*, vol. ii., 1877, p. 156), only sodium gives a spectrum approaching in intensity that which it gives in a reducing flame.

(2) The phenomena of the "basic" Bessemer blow differ considerably from those of the "acid" process.

First, a flame is visible from the commencement of blowing. The immediate production of this flame is caused by carbonaceous matter in the lining of the vessel, its luminosity is due partly to the volatilisation of the alkalies, and to the incandescence of lime dust carried out by the blast.

Secondly, volatilisation of metal occurs largely at an early period in the blow, and is due chiefly to the smaller quantity of silicon present.

Thirdly, a very large amount of fume is formed towards the close of the second period. The flame is comparatively short, and the metallic vapours carried up are burnt by the blast.

Fourthly, the "over blow" is characterised by a very powerful illumination from what appears to be a brilliant yellow flame: a dense fume is produced at this time composed of oxidised metallic vapours, chiefly iron. The spectrum is continuous, but does not extend beyond wave-length 4000. The light emanates from a torrent of very small particles, liquid or solid, at a yellowish-white heat.

Fifthly, the spectra of flames from the first stage of the "basic" process differ from those of the "acid" process in several particulars. The manganese bands are relatively feeble, and lines of elements, not usually associated with Bessemer metal, are present. Lithium, sodium, potassium, rubidium and cæsium have been traced mainly to the lime used; manganese, copper, silver and gallium to the metal.

(3) Differences in the intensity of metallic lines. The intensity of the lines of any metal varies with the amount of the metal in the charge, but they are also to be traced to changes in temperature; as the temperature of the flame rises, some lines

fade almost away, others become stronger. The changes are more marked in the arc spectrum and still more in the spark spectrum of iron.

A new line of potassium with variable intensity. This line, wave-length approximately 4642, varies in intensity within somewhat wide limits. In a given flame its brilliancy is increased by diminishing the quantity of metallic vapour in the flame: this does not appear to depend altogether on the weakening of the continuous spectrum; it is probably due, in part at least, to the increased freedom of motion permitted to the molecules of the metal.

February 21.—"Notes on the Spark Spectrum of Silicon as rendered by Silicates." By W. N. Hartley, F.R.S.

March 7.—"On the Composition and Variations of the Pelvic Plexus in *Acanthias vulgaris*." By Mr. R. C. Punnett, B.A., Gonville and Caius College, Cambridge. Communicated by Dr. H. Gadow, F.R.S.

"Preliminary Communication on the Œstrous Cycle and the Formation of the Corpus Luteum in the Sheep." By F. H. A. Marshall, B.A. Communicated by Prof. J. C. Ewart, F.R.S.

Physical Society, March 8.—Dr. R. T. Glazebrook, foreign secretary, in the chair.—A paper on a theory of colloidal solutions was read by Dr. F. G. Donnan. Assuming that a colloidal solution is not a true molecular intermixture, but a two-phase system consisting of exceedingly minute aggregates of the colloid distributed throughout the solvent, the object of the paper was to examine how such a state of affairs might be imagined to come about. By applying the fundamental notions of Laplace's theory of capillary forces to the statical (mechanical) equilibrium at the interface, it was shown that under certain conditions matter in bulk might disintegrate into a homogeneous liquid medium and yet not attain a state of molecular division, remaining distributed in the form of very thin filaments or sheets whose thickness is comparable with the sphere of molecular attraction. True solution, or molecular intermixture, is regarded, on the other hand, as arising from the kinetic flux of molecules across the interface. Dr. Gladstone said that the study of colloids was one which had been too much neglected. It involves both a knowledge of physics and of chemistry. A colloid is an unstable body and is always altering its composition. Water of combination is given off on heating, even if the surrounding atmosphere is saturated, and the colloid cannot take up the water again. It is impossible to separate colloids and crystalloids—they merge into one another. The transition forms are not uncommon. Dr. Lehfeldt asked if it had been proved that colloids have osmotic pressure. Prof. Threlfall said that in colloidal solutions some of the substance was not in suspension. Dr. Martin had filled a filter with silicic acid under pressure, and found that it allowed sugar solution to pass through but stopped colloidal solutions. The author had used opacity as a test for colloids, but silicic acid could be got transparent. There are two kinds of opalescence—one cannot be removed and exists because the substance is a two-phase system; the other can be removed with difficulty by filtering, and leaves a transparent substance. The want of transparency should be used cautiously as an argument. Dr. Donnan, in reply to Dr. Gladstone's remarks on the transition from crystalloids to colloids, said that a substance might be a crystalloid with one medium and a colloid with another. In reply to Dr. Lehfeldt, he said that the only evidence in favour of osmotic pressure of colloids is that colloidal solutions diffuse. He agreed with Prof. Threlfall that opacity should be used carefully as an argument, but stated that his theory referred to a two-phase system. —Mr. Appleyard then exhibited three pieces of apparatus. The first was a slide wire bridge for measuring conductivities of wires. The slide wire instead of forming two arms of the bridge forms only one, and the length used is proportional to the conductivity to be measured. If the arm which contains the standard wire used is altered, it becomes necessary to alter the divisions of the scale on the slide wire. This is done by a mechanical arrangement. The second piece of apparatus was a mechanical gauge for measuring the diameters of spheres. The sphere to be measured is placed between a metal face plate and a piece of glass at the end of the short arm of a pivoted lever. The end of the long arm of the lever moves over a graduated scale which is calibrated to show directly the diameter of the sphere. The third piece of apparatus was a galvanometer fitted up for lamp and scale work. The illumination was produced by a 4 volt ¼-candle power lamp, and it was shown that very good results could be obtained from this by using a large condensing lens. Prof. Threlfall said he had usually used a straight piece of the lamp filament itself, instead of using the lamp in conjunction with a cross wire.—A paper, by Prof. R. W. Wood, on the production of a bright line spectrum by anomalous dispersion and its application to the flash spectrum, was postponed until the next meeting at Burlington House, when the subject will be experimentally illustrated by Mr. Watson.—The Society then adjourned until March 22, when the meeting will be held in the chemical laboratories of University College, London.

Geological Society, February 15.—Annual General Meeting.—J. J. H. Teall, F.R.S., president, in the chair.—It was stated that, the Council having undertaken to supply to the Regional Bureau of the International Catalogue of Scientific Literature the material referring to geology published in the British Islands, Mr. C. Davies Sherborn had been appointed to prepare and edit the catalogue-slips necessary for that purpose. The reports having been adopted, the medals and funds of the Society were awarded as already announced (p. 402) —The president then proceeded to read his anniversary address, in which he first gave obituary notices of several Fellows and Foreign Members deceased since the last annual meeting. He then dealt with the evolution of petrological ideas during the nineteenth century, especially as regards the igneous rocks. The discussions as to the origin of basalt and granite were referred to, and it was shown that the controversy regarding the latter rock had contributed largely to the clearing up of our ideas as to the nature of plutonic phenomena. The solution-theory propounded by Bunsen was especially emphasised, and its modern developments were briefly sketched. It was suggested that the next great advance will, in all probability, be the result of experiment, controlled by the modern theory of solutions, and carried out for the purpose of testing the consequences of that theory and discovering the modifications which may be necessary to adapt it to igneous magmas. The bearing which recent work on alloys had on petrographical problems was also referred to. The problem of the origin of petrographical species was next considered, and the growth of ideas on the subject briefly sketched. It was pointed out that although magmatic differentiation is accepted by many as an important factor in producing different kinds of igneous rocks, it does not rest on any assured experimental basis. Differentiation dependent on, or connected with, the crystallisation of definite minerals was reviewed more favourably; but it was pointed out that all theories of differentiation which are based on unaided molecular flow are subject to the criticism that the time required to effect any important differentiation appears to be too great. Reference was also made to recent work on the modification of igneous magmas by the inclusion and assimilation of rocks through which they pass; and the conclusion was reached that the origin of species, so far as igneous rocks are concerned, is a problem the final solution of which has been handed on by the nineteenth century to its successor.

Royal Astronomical Society, March 8.—Dr. J. W. L. Glaisher, F.R.S., president, in the chair.—Lantern slides were exhibited of photographs of the region of the new star in Perseus, taken by Mr. Stanley Williams. One, taken on February 20, only twenty-eight hours before its discovery, showed no trace of the Nova, though containing stars to about the twelfth magnitude.—Dr. Lockyer showed photographs of the spectrum of the new star, taken at South Kensington. The spectrum showed dark lines of hydrogen, and also broad, bright hydrogen bands displaced towards the red, apparently indicating two sources of light and enormous relative velocities. The spectrum showed the existence in the star of hydrogen, calcium, iron, &c.—Mr. McClean exhibited an enlargement from his photograph of the spectrum, in which he could find no trace of helium. The spectrum of the Nova resembled that of Sirius, but with bright bands of hydrogen; it was also much like that of Nova Aurigæ.—A photograph of the spectrum taken at Stonyhurst was also shown.—Mr. Newall exhibited and explained his photographs of details of the spectrum, taken at Cambridge.—Dr. Rambaut gave results of observations made at Oxford. The colour of the Nova was first of a bluish-white, becoming redder as it diminished in light.—The Astronomer Royal showed photographs taken at the Royal Observatory, where observations were made of the magnitude, which showed a gradual but not perfectly regular, diminution of brightness from 0·5 magnitude on February 25 to 3·1 magnitude on March 6.—Mr. Bellamy brought forward a series of measures

of the position of the Nova, from a photograph taken at the University Observatory, Oxford.—Mr. Bryan Cookson gave a description, illustrated with lantern slides, of a new photographic zenith telescope, constructed with a view to the determination of the constant of aberration. The essential feature of the ordinary zenith telescope is the *level*, but in this new form of the instrument there is no level, verticality of the axis being obtained by floating the supports of the telescope in a bath of mercury. Mr. Cookson also gave some preliminary results obtained with the new instrument.—Nine other communications were taken as read.

Linnean Society, February 21.—Dr. A. Günther, F.R.S., vice-president, in the chair.—Mr. R. Morton Middleton exhibited and made remarks on a series of Virginian oysters of certified ages.—Mr. H. E. Smedley exhibited with the aid of the lantern a series of photomicrographs illustrating the histology of various types of plants. Mr. Smedley also showed some fossil remains of *Balaena* from the Crag, with other undetermined bones.—A paper by Prof. E. Ray Lankester, F.R.S., and Mr. R. Lydekker, F.R.S., on the affinities of *Æluropus melanoleucus*, was read by Mr. Lydekker. The authors based their views on an examination of a cast of the skull presented by the late Prof. Milne-Edwards to the Oxford University Museum, and certain limb-bones and a fine skull in the Natural History Museum, South Kensington, all of which were described. The conclusions arrived at were that in important and distinctive points *Æluropus* agrees with *Ælurus* and *Procyon* (more closely with the former) and differs widely from *Ursus*, notwithstanding its external resemblance to the last named. The salient points in the anatomy of each were discussed, and the resemblances and differences made clear by a series of photographs which were exhibited.—A paper by Monsieur A. Gruvel, entitled "Étude d'une espèce nouvelle de Lepadides," was communicated by Prof. Howes, who gave an abstract of the same, and exhibited drawings of the new species (*Scalpellum maximum*) described by the author. The paper also dealt with examples of *Poecilasma carinatum* which were found attached to a specimen of the *Scalpellum*.

Anthropological Institute, February 25.—Prof. Haddon, F.R.S., president, in the chair.—Mr. H. Ling Roth read a paper on Maori tatu and moko. The paper, which was fully illustrated by lantern slides, opened with an explanation of the difference between tatu and moko; by the former is understood production of a pattern by puncturing the skin and depositing colouring matter under it; in the final state the skin is perfectly smooth. In moko, on the other hand, the instrument is a chisel and leaves slight grooves in the skin after the wound is healed. The Maoris made use of spirals and coils in their patterns, differing in this respect from other Polynesians. The instrument, which is really a miniature hoe, is placed on the skin and tapped with a mallet. The operation is extremely painful, involving great loss of blood, so that only a small portion of the pattern can be done at once. The portions of the body operated on are the face and thighs, and in the case of the latter the effect is that of an ornamental pair of drawers. The operation was begun at puberty and small additions were continually made, especially after a successful fight or on similar important occasions. The most elaborately tatued was most favoured by the fair sex. In some cases post mortem moko was employed to increase the value of a specimen.—Major-General Robley presented a drawing of a Maori war dance.

EDINBURGH

Mathematical Society, March 8.—Some elementary theorems regarding surds, by Prof. Chrystal.—Note on the application of complex integration to the equation of conduction of heat, by Mr. John Dougall.

PARIS.

Academy of Sciences, March 4.—M. Fouqué in the chair.—On the new star which recently appeared in the constellation of Perseus, by M. J. Janssen. In stars such as the sun, in which the temperature is too high for water to exist, as the temperature falls there must come a point at which combination of the hydrogen and oxygen will suddenly take place. This would be accompanied with an enormous and sudden increase of temperature and hence of light production, and this is put forward as a possible explanation of the appearance of a new star. At the moment of combination, on account of the pressures and temperatures developed, the rays of the spectrum ought to be considerably enlarged, and this is precisely what appears in the spectra obtained at Meudon.—Meridional sight with cylindrical mirror, by M. G. Lippmann. A description of an apparatus for measuring right ascensions, in which the meridian is shown as a luminous line projected upon the sky. With this apparatus a cross wire in the eyepiece is rendered unnecessary.—On the preparation and properties of sulph-ammonium, by M. Henri Moissan. The three varieties of sulphur were submitted to the action of liquefied ammonia at $-80°$ C.; no reaction takes place, but on allowing the temperature to rise slowly solution occurs with sulphur insoluble in carbon bisulphide at $-38°$, with prismatic sulphur at $-15°{\cdot}5$, and with the octahedral variety at $-11°{\cdot}5$. From this solution a new compound, sulphammonium, can be obtained, of a dark red colour, and having at $-23°$ the composition $(NH_3)_2S$, at $20°$, $(NH_3)_2S.2NH_3$, which is completely dissociable at the ordinary temperature and pressure, and which possesses the property of being able to add sulphur in the cold to a large number of simple and compound bodies.—A method of estimating sulphides, sulphydrates, polysulphides and hyposulphites coexisting in solution, in particular in certain mineral waters, by M. Armand Gautier. The method proposed is based upon the facts that sulphhydrates, distilled in a vacuum, give up all their sulphuretted hydrogen in excess of that required to form the monosulphide, and this, again, yields the whole of its sulphur on distilling in a current of carbon dioxide. Test analyses are given of a water prepared synthetically and of the mineral water of Labassère.—On germination in distilled water, by MM. P. P. Dehérain and Demoussy. Seeds can form their roots and commence their development in distilled water absolutely deprived of lime, although this development is arrested when the distilled water contains unweighable traces of copper.—A phototherapic apparatus without a condenser, by MM. Lortet and Genoud. The size of the active zone in the apparatus described may be varied from 1 to 6 cm. in diameter, the zone from an apparatus using a condenser being much smaller. The time necessary for the exposure is also reduced to one-fourth of that required in the older form of apparatus.—Observations on the brightness of the planet Eros made at the Observatory of Lyons, by MM. Guillaume, Le Cadet and Luizet. The results are shown in the form of a curve having a period of about 2h. 50m., the total variation of light being about two magnitudes.—On the variation of brightness of the planet Eros, by M. M. Luizet. A mathematical discussion of the results of the previous paper.—Variations of brightness of the planet Eros, by M. Baillaud. From observations made at the Observatory of Toulouse, the period between the times of maximum brightness is found to be the same as between the minima, 2h. 23m.—The elements of the system formed by the double planet Eros, by M. Ch. Andre. The time of revolution of the satellite of Eros is nearly that of Phobos, the eccentricity is nearly equal to that of the lunar orbit, and the mean density of the system is of the order of that of Mars.—On the period of the variability of brightness of the planet Eros, from determinations made at the Observatory of Toulouse, by M. L. Montangerand. The period deduced is 2h. 22m.—On the new star in Perseus, by M. M. Luizet. A comparison of the magnitude of the new star with α-Taurus, β-Gemini, α-Perseus, and γ-Cassiopeia.—Observations on the new star in Perseus, by M. H. Deslandres. A detailed study of the spectrum of the new star (see p. 477).—On a certain surface of the third order, by M. D. Th. Egorov.—On complete systems of partial differential equations, by M. Edmond Maillet.—On the propagation of the Hertzian oscillations in water, by M. C. Gutton. It is shown that the wave-length remains the same when the resonator and the transmitting wires are immersed in water.—The law of transparency of matter for the X-rays, by M. L. Benoist.—On the induced radio-activity provoked by radium salts, by MM. P. Curie and A. Debierne. The experiments cited show that the induced radio-activity is transmitted by the air, and this is in agreement with the hypothesis of Rutherford.—On a new method for determining the atomic weight of uranium, by M. J. Aloy. The nitrate is decomposed, and the ratio of nitrogen to uranium nitrate determined.—Thermal study of the ammoniacal aluminium chlorides, by M. L. Baud.—On a new silicide of cobalt, by M. Paul Lebeau. The new silicide, which has the composition CoSi, is obtained by heating metallic cobalt and copper silicide in the electric furnace.—On the mixed organo-magnesium compounds, by M. V. Grignard (see p. 477).—On an isomeride of anethol and on the constitution of the latter, by MM. Behal and Tiffeneau. Anisol, treated

with magnesium-methyl iodide, gives a propenyl anisol and a polymer. The composition of the ketone formed from this on hydrolysis leads to the conclusion that anethol possesses a propylenic chain.—On the phenylhydrazones of glucose and their multirotation, by MM. L. J. Simon and H. Bénard.—A general method for the synthesis of the naphthenes, by MM. Paul Sabatier and J. H. Senderens. At 170° to 200° all the hydrocarbons tried were readily hydrogenised by reduced nickel. Details are given of the preparation of the hexahydro-compounds of toluene, orthoxylene and its meta- and para-isomers, ethyl benzene, mesitylene, pseudocumene and propylbenzene.—The specific and latent heat of fusion of ethylene glycol, by M. de Forcrand.—On the constitution of gentianose, by MM. Ed. Bourquelot and H. Hérissey.—The treatment by oxygen at atmospheric pressure of persons poisoned by carbon monoxide, by M. N. Gréhaut. The elimination and disappearance of the poison is considerably accelerated by the use of oxygen, which thus becomes essential in the treatment of cases of carbon monoxide poisoning.—The analogies between the diastatic actions of colloidal platinum and those of organic diastases, by M. G. Bredig.—The coagulating properties of mucus and its origin and consequences, by MM. Charrin and Moussu.—On a differential histochemical reaction of leucocytes and on the experimental production and the nature of the chromatophile granulations of its cells, by M. Henri Stassano.—New observations on the organisation of the Gasteropods, *Pl. Quoyana* and *Pl. Beyrichi*, by MM. E. L. Bouvier and H. Fischer.—On the different cells of the ovary which intervene in the formation of the egg in insects, by M. A. Lécaillon.—On the mechanism of the propulsion of the tongue in amphibians, by M. Marcus Hartog.—On the geotropism of the roots of the vine, M. J. M. Guillon.—On the discovery of a glossopterian flora and of the reptiles *Pareiasaurus* and *Dicynodon* in the upper Permian deposits of the north of Russia, by M. V. Amalitzky.—The tertiary and quaternary deposits of the valley of Bellegarde, by M. H. Douxami.

DIARY OF SOCIETIES.

THURSDAY, MARCH 14.

ROYAL SOCIETY, at 4.30.—The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases: C. E. S. Phillips.—The Chemistry of Nerve-degeneration: Dr. Mott, F.R.S., and Prof. Halliburton, F.R.S.—On the Ionisation of Atmospheric Air: C. T. R. Wilson, F.R.S.—On the Preparation of Large Quantities of Tellurium: E. Matthey.

ROYAL INSTITUTION, at 3.—Greek and Roman Portrait Sculpture: Prof. Percy Gardner.

MATHEMATICAL SOCIETY, at 5.30.—On the Composition of Group-Characteristics: Prof. Burnside, F.R.S.—On the Use of Cauchy's Principal Values in the Double Limit Problems of the Integral Calculus: G. H. Hardy.—Some Algebraical Identities of Simple Arithmetical Application: Prof. Elliott, F.R.S.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Growth and Trend of Indian Trade—a Forty Years' Survey: H. J. Tozer.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Notes on Polyphase Substation Machinery: A. C. Eborall.

FRIDAY, MARCH 15.

ROYAL INSTITUTION, at 9.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Combined Trolley and Conduit Tramway Systems: A. N. Connett.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Enteric Fever Mortality in Copenhagen from 1828–1898: Dr. N. P. Schierbeck.—The Effect of Sewerage and Water Supply upon the Behaviour of Enteric Fever in Buenos Ayres: Dr. J. T. R. Davison.

SATURDAY, MARCH 16.

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

MONDAY, MARCH 18.

SOCIETY OF ARTS, at 8.—Electric Railways: Major P. Cardew.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—The Topography of South Victoria Land: L. C. Bernacchi.

VICTORIA INSTITUTE, at 4.30.—Religion and Art: Rev. T. Hunter Boyd.

CAMERA CLUB, at 8.15.—Discussion on Panoramic Photography.

TUESDAY, MARCH 19.

ROYAL INSTITUTION, at 3.—The Cell as the Unit of Life: Dr. A. Macfadyen.

ZOOLOGICAL SOCIETY, at 8.30.—On New or Imperfectly-known Ostracoda, chiefly from a Collection in the Zoological Museum, Copenhagen: Dr. G. S. Brady, F.R.S.—On *Lemur mongoz* and *L. rubriventer*: Dr. C. I. Forsyth Major.—On the Hymenoptera collected in New Britain by Dr. Arthur Willey: P. Cameron.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Æsthetic Treatment of Bridge Structures: J. Husband.

MINERALOGICAL SOCIETY, at 8.—Notes on an Occurrence of Minerals at Haddam Neck, Connecticut, U.S.A.: H. L. Bowman.—On Calaverite from the Cripple Creek District, Colorado, U.S.A.: G. F. Herbert Smith.—On the Arrangement of the Chemical Atoms in Boracite and Cassiterite: W. Barlow.

ROYAL STATISTICAL SOCIETY, at 5.—Results of State, Municipal, and Organised Private Action on the Housing of the Working Classes in London and in other Large Cities in the United Kingdom: Dr. John F. J. Sykes.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photographing Stained Glass by the Three-colour Process: Chas. B. Howdill.

WEDNESDAY, MARCH 20.

SOCIETY OF ARTS, at 8.—Evolution of Form in English Silver Plate: Percy T. Macquoid.

GEOLOGICAL SOCIETY, at 8.—On a Remarkable Volcanic Vent of Tertiary Age in the Island of Arran, enclosing Mesozoic Fossiliferous Rocks: B. N. Peach, F.R.S., W. Gunn, and E. T. Newton, F.R.S.—On the Character of the Upper Coal Measures of North Staffordshire; their Comparison with those of Denbighshire, South Staffordshire, and Nottinghamshire; and their Relation to the Productive Series: Walcot Gibson.

ANTHROPOLOGICAL INSTITUTE (Albemarle Street), at 8.—Joint Meeting with the Folklore Society.—Sand Ropes and other Futile Tasks: G. M. Godden.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Climate, and the Effects of Climate: Dr. Hugh Robert Mill.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Metallography of Iron and Steel: Wm. H. Merrett.

INSTITUTION OF MINING AND METALLURGY, at 8.—Annual General Meeting.—Followed by: The Electric Power Station at the Pierrefitte Mine: E. Henry Davies.—(1) Note on Smelting Lead-Copper Ore; (2) Note on Lead Assaying: P. R. Robert.

THURSDAY, MARCH 21.

ROYAL SOCIETY, at 4.30.—Studies in Visual Sensation (Croonian Lecture): Prof. C. Lloyd Morgan, F.R.S.

LINNEAN SOCIETY, at 8.—On the Intestinal Tract of Birds, and the Valuation and Nomenclature of Zoological Characters: P. Chalmers Mitchell.

CHEMICAL SOCIETY, at 8.—Researches on Morphine, Part II: S. B. Schryver and F. H. Lees.—The Constitution of Pilocarpine, Part II.: H. A. D. Jowett.—Note on the Latent Heats of Evaporation of Liquids: Holland Crompton.—(1) Action of Dry Silver Oxide and Ethyl Iodide on Benzoylacetic Ester, Desoxybenzoin, and Benzyl Cyanide; (2) Alkylation of Acylarylamines: G. D. Lander.

CAMERA CLUB, at 8.15.—Yorkshire Caves and Waterfalls: T. C. Hepworth.

FRIDAY, MARCH 22.

ROYAL INSTITUTION, at 9.—Some Recent Work on Diffusion: Dr. Horace Brown, F.R.S.

PHYSICAL SOCIETY (University College, Gower Street), at 5.—On the Expansion of Silica: Prof. Callendar, F.R.S.—The Spectroscopic Apparatus at University College: Dr. E. C. C. Baly.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Hunslet Railway and Bridge over the River Aire: O. L. McDermott.

SATURDAY, MARCH 23.

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

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