THURSDAY, APRIL 27, 1916.

ANCIENT HINDU SCIENCE.

The Positive Sciences of the Ancient Hindus. By Dr. B. Seal. Pp. viii + 295. (London: Longmans, Green and Co., 1915.) Price 12*s.* 6*d.* net.

A CHARACTERISTIC feature of the present-day literary activity of the philosophically minded men of science in India is seen in the commentaries they are publishing from time to time on their ancient systems of scientific doctrine, partly, no doubt, with the object of enlightening Western nations concerning the existence in these systems of certain root-ideas which are usually held by us to be the product of Western thought alone. The more our knowledge grows the more certainly will it be seen that many of these fundamental concepts are common to all systems of philosophy, and that, in the absence of an accurate chronology, it becomes increasingly difficult to determine where or with whom their germs originated. It is possible, of course, that some of these fundamental ideas were independently conceived, but it is equally probable that they may have had a common origin or have been radiated from a common source. In such case there is ground for the supposition that this common source was India. But in reality it is impossible to say with any approach to accuracy how Eastern knowledge travelled in the far-off times to which we are referring. We can only surmise that these ancient philosophies found their way along trade routes through Persia, Mesopotamia, Syria, to the Greeks and Egyptians, and thence along the Mediterranean littoral into Spain and western Europe.

In the book before us Dr. Brajendranath Seal makes no exaggerated claim to the antiquity of the body of knowledge with which he deals. Indeed, he says in the present state of Indian chronology it is impossible to assign dates to the original sources from which his materials have been drawn. Practically, he thinks it may be assigned to the millennium 500 B.C. to 500 A.D., which is comparatively late in the history of human thought. With respect to the West all he definitely asserts is that the Hindus had, if not a prior claim, at least an independent share with the Greeks in the work of constructing scientific concepts and methods in the investigation of physical phenomena. Indeed, it is probable that they were earlier than the Greeks in accumulating a body of knowledge capable of being applied to industrial technique. It is at least certain that Hindu scientific ideas deeply influenced the course of natural philosophy in Asia—in China and Japan towards the east and in the Saracen empire in the west.

The book under review consists of a series of monographs on the positive sciences of the ancient Hindus. Some portion of it has already appeared in Dr. P. C. Rây's "Hindu Chemistry," viz., the chapters dealing with the mechanical, physical, and chemical theories of the ancient Hindus and with their scientific methods. The author regards his book as preliminary to a more comprehensive work on comparative philosophy, since philosophy in its rise and development is necessarily governed by the body of positive knowledge preceding or accompanying it. Hindu philosophy, he considers, on its empirical side was dominated by concepts derived from physiology and philology, whereas Greek philosophy was dominated by geometrical concepts and methods. The ultimate object of his labours, apparently, is to attempt a comparative estimate of Greek and Hindu science, with, it is hoped, a measure of success and some approach to finality.

Dr. Rây's work on "Hindu Chemistry" has already been the subject of notice in these columns. On the present occasion, therefore, we purpose to restrict ourselves to an examination of the chapters dealing with Hindu ideas on kinetics and acoustics; on plants and plant-life; on the classification of animals; and on Hindu physiology and biology.

To begin with, a Western student of the book meets with an initial difficulty in the different systems of transliteration adopted by the two contributors. It is to be hoped, in the interests of uniformity, that if Western literature continues to be augmented by Eastern contributions of this character some understanding on this matter may be arrived at. It is difficult enough as it is for the Western mind to assimilate Eastern thought, or to appreciate its subtle *nuances,* without the difficulty being unreasonably increased by a matter which is surely capable of satisfactory settlement by philologists. A more serious difficulty consists in the employment by the author of terms like "isomeric," "polymeric," etc., which are essentially modern, and used by us in a perfectly definite sense to express modern ideas, but which in the book are adopted to connote conditions which are only very remotely analogous. Dr. Brajendranath Seal is well aware of what he admits is a questionable freedom. It would be difficult in all cases to suggest an alternative, but it must be admitted that the loose use of well-defined modern terms to express vague or only very distantly related ideas does not conduce to accurate thinking.

The chapter on mechanics deals with ancient Hindu ideas of the analysis of motion; of motion considered in relation to its causes; of motion not due to material contact of which the mechanical causes are unknown, and which are to be ascribed to the universal final cause (Adrista), *e.g.,* the first motion of primordial atoms, the upward motion of gaseous particles, the movement of iron towards the magnet, capillary motion as of liquid particles from the root to the stem of a plant, etc. The idea attached to the hypothesis of Adrista (which simply means "unseen") seems to have been modified in the course of time. Originally it would appear to have been used as an expression for agnosticism, no transcendental interpretation being attached to it. The chapter next treats of force; the causes of pressure, and of impact; gravity; curvilinear, vibratory, and rotatory motion; fluidity and the motion of fluids; measurement of motion; units of time and space; relative and serial motion. The author shows no inclina-

tion to see anticipations which are not strictly legitimate. He points out that the Vaiśeṣika theory of motion made only a distant approach to Newton's first law of motion, and that whilst a good foundation was laid for the explanation of the accelerated motion of falling bodies, Galileo's discovery was not anticipated. But there would seem reason to believe that Vâchaspati laid the foundations of solid geometry eight centuries before Descartes, and that Bhâskara (1150 A.D.), in computing planetary motion, appears to have used the differential calculus.

Ancient ideas on acoustics have a remarkable similarity to modern theories. It was recognised that the air was the physical basis of audible sound, and that its propagation was to be conceived on the analogy of waves in water. Various views, however, seem to have been held concerning the precise nature of the air-waves, as to the character of the vibratory movement, and how the molecules of a vibrating bell communicate their motion to the contiguous air-molecules. Echo was supposed to be a reflection of sound as an image in a mirror is a reflection of light. Attempts were made to explain pitch, intensity, and timbre by differences in the characteristics of the air-waves. The nature of musical sounds and intervals was the subject of acute speculation. Medieval compilations explain musical tones and their relations with reference to melody, as harmony was altogether unknown.

The wonderful plant-life of India naturally stimulated attempts at classification, and a short account of the various systems attributed to Charaka, Praśastapâda, Amara, and others is included in chapter iv. A section is devoted to elementary ideas of plant physiology, characteristics of plant-life, sexuality, and consciousness. It is a curious and suggestive chapter, not without interest to the modern plant-physiologist.

Not less interesting are the early Hindu attempts at the classification of animals based upon mode of origin—whether placental, oviparous, from moisture and heat, or from vegetable organisms. Snakes naturally received much attention, and elaborate accounts are given of the action of the poison of the several venomous families. This is one of the longest chapters in the book, and the accounts of the various systems are given in considerable detail.

Space precludes any attempt to give any description of ancient Hindu ideas concerning physiology and biology. Naturally, the phenomena of metabolism, of the circulatory system, and of the vascular and nervous system; of the seat of consciousness; of fœtal development; sex; heredity, received attention, and were the subject of speculation, often based upon acute and accurate observation, always interesting, and frequently highly suggestive. But enough has been stated to show that Dr. Brajendranath Seal has given us a most valuable contribution to the history of science by means of a work which must have involved a vast amount of study and research into a literature which is practically inaccessible to European students of physical science.

BRITISH FRESH-WATER RHIZOPODS.

The British Fresh-water Rhizopoda and Heliozoa. By J. Cash and G. H. Wailes. Vol. iii. *Rhizopoda.* Part iii. By G. H. Wailes. Pp. xxiv + 156 + plates xxxiii + lvii. (London: Ray Society, 1915.) Price 12*s.* 6*d.* net.

TO say that the volume before us equals, if it does not surpass, its predecessors, not only in scientific value but in general construction, is to award it the highest praise. With the completion of their task by the publication of the concluding volume it will not be too much to state that what Leidy has done for the fresh-water Rhizopoda of North America the authors of this work will have done for the group in Great Britain. Since the publication of the second volume (in 1908) the senior author, James Cash, has died, and a sympathetic biography forms a fitting introduction to this volume from the hand of Mr. John Hopkinson, who, as is well known, rendered him material assistance in the preparation of vol. ii., and to whom the present instalment is indebted for a series of synonymies which may well serve as a pattern for all systematists, and may be said to constitute a practically complete bibliography of the subject.

The volume furnishes a very extended addition to our knowledge of the distribution of these organisms in the British Isles, especially by the incorporation of the splendid results of the labours of Mr. G. H. Wailes (which were embodied in his monograph of the group published in the reports of the Clare Island Survey), who now joins Mr. Hopkinson as one of the authors of this book. By the addition to the British list of Paulinella and Clypeolina, and the representation of Gromia by Allogromia and Rhynchogromia, the number of fresh-water Rhizopoda recorded as British is raised from forty-seven to fifty. The confused species *Euglypha alveolata* is divided into *E. acanthophora* and *E. tuberculata,* a simplification which will be welcomed by students of the group, supported as it is by a remarkable synonymy comprising no fewer than 157 well-considered references.

The authors direct attention to the specialised method of collecting reserve scales by *E. cristata,* and the contrivance by which the apex of the test is closed in *E. mucronata.* The new classification of the Gromiinæ will appeal as much to students of the marine as of the fresh-water Rhizopoda. In this section the preoccupied name Pamphagus is replaced by Lecythium, as the outcome of a laborious study of the existing synonymies. We do not agree with Rhumbler (who is followed by the authors) that Dujardin failed to notice the anastomosing reticulations of the pseudopodia of *Gromia oviformis;* his four papers published in 1835 (Ann. Sci. Nat., 1835, "Infusoires," 1841) make the contrary view clear, but for taxonomical purposes Rhumbler's sub-family, Allogromia, is undoubtedly useful. An interesting account is given of the reproductive processes of *Microgromia socialis,* as also of the indifferently marine or fresh-water genera, Lieberkuehnia and Rhyn-

chogromia. The late J. D. Siddall was of the opinion that his remarkable genus, Shepheardella, shared this indifference to habitat, but did not publish his conclusions on the matter.

The twenty-five plates in colour and monotone are worthy of the best traditions of the Ray Society. Vol. iv., which will complete this admirable work, will consist of two parts: the first an addendum to vols. i. and ii., comprising species recorded as new to Britain since their publication; the second, dealing with the Heliozoa, will be the work of Messrs. Hopkinson and Wailes. E. H.-A.

MATHEMATICAL TEXT-BOOKS.

(1) *The Essentials of Descriptive Geometry.* By Prof. F. G. Higbee. Pp. vi+204. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 7*s.* 9*d.* net.

(2) *Five-Figure Mathematical Tables.* Compiled by E. Chappell. Pp. xvi+320. (London: W. and R. Chambers, Ltd., 1915.) Price 5*s.* net.

(3) *Mortality Laws and Statistics.* By R. Henderson. Pp. v+111. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) 5*s.* 6*d.* net.

(4) *Arithmetic for Carpenters and Builders.* By Prof. R. B. Dale. Pp. ix+231. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 5*s.* 6*d.* net.

(5) *Handy Logarithmic Tables.* By Y. Uraguchi. Pp. 7. (Tokyo: Y. Uraguchi, 1915.) Price 3*d.*

(1) THE author assumes on the part of the reader no previous knowledge of descriptive geometry, and only quite a superficial acquaintance with ordinary plane geometry. The course follows mainly the customary lines, including points, lines, angles, planes, surfaces, and model-making. There are three reasons why its general character should commend itself to the ordinary student. First, the diagrams are numerous, clear, and unusually large; secondly, the style of exposition is admirably lucid; and thirdly, each chapter closes with a set of simple exercises; it would be a distinct improvement if answers were added, where possible.

(2) This book of five-figure tables includes logarithms of number and their reciprocals, antilogarithms (called illogs), logarithms of logarithms (called lologs), anti-"logarithms of logarithms" (called illologs), the trigonometric functions and their logarithms, and a table of various constants. To lessen, in using the lolog tables, the chance of error which would occur from failure to notice whether the logarithms are positive or negative, numbers less than unity are shown in red, and those greater than unity in black. This is a wise precaution. The book is well printed and arranged in a convenient fashion.

(3) The author sets out in scientific form the results of investigations into the duration of human life and the mathematical theory required for it. The book is a treatise for actuaries or for mathematicians interested in the theory of probability. The author has excluded the combination of life contingencies with the theory of compound interest, annuities, etc., and has confined himself strictly to life contingencies.

After opening with an historical account of the way in which mortality tables came to be compiled and improved, he proceeds to discuss the construction and graduation of tables now in use, and gives various modern tables in an appendix.

(4) This small text-book is admirably suited to meet the needs of the practical workman. It deals with the elements of arithmetic, but includes also a great deal of general and technical information, such as the use of tools, cost of material, economy of arrangement, and simple designs. The student who reads and works thoroughly through its pages will acquire a considerable store of valuable information: a worthy addition to an excellent series.

(5) These four-figure tables are printed on a thickish sheet of paper, 7 in. high, 31 in. long, folded into seven parts, and contain proportional parts, logarithms of number and their reciprocals, and anti-logarithms. We doubt whether they possess any advantage over the ordinary forms in use.

OUR BOOKSHELF.

The Mathematical Theory of Probabilities and its Application to Frequency Curves and Statistical Methods. By A. Fisher. Translated by W. Bonynge. Volume i. *Mathematical Probabilities and Homograde Statistics.* Pp. xx+171. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 8*s.* 6*d.* net.

IT is remarkable that, in spite of the number of older works in English on the theory of probabilities and the great attention that has recently been devoted to statistical method, no modern work on the subject in our own language existed. Mr. Fisher's work will do much to fill this gap.

After an introduction on the general principles and the philosophical aspect of the subject, and a somewhat slight historical sketch, he develops the fundamental theorems of probabilities, the laws of mathematical expectation, probability *a posteriori* and Bayes's theorem, the law of large numbers, and the theory of dispersion. This theory is then applied to games of chance and to statistical problems. A second volume is promised on the theory of frequency curves.

The treatment is very lucid—the chapter on Bayes's theorem may be selected as a marked example—and the work will be of considerable service to the statistical student. It is to be regretted, however, that the author has not taken up some of the more difficult problems of statistical work and has stopped short at the elementary comparison of the actual dispersion of a series with the combinatorial dispersion.

There is no index, and it is to be hoped the promised second volume will supply one. In a future edition the spelling of proper names should receive attention.

Tuberculosis: A General Account of the Disease; Its Forms, Treatment, and Prevention. By Dr. A. J. Jex-Blake. Pp. viii+231. (London: G. Bell and Sons, Ltd., 1915.) Price 2*s.* 6*d.* net.

AN excellent account of the subject of tuberculosis is given in this book, free from technicalities, so that it should be easily intelligible to those who possess no special education in medical or scientific matters.

The opening chapter deals briefly with the historical side of the subject, and then the tubercle bacillus is discussed. The different types of the bacillus are described—their occurrence and relationship to the disease in man—and a summary is given of the vexed question of the infection of man from bovine sources, in which both sides of the controversy are placed before the reader.

Predisposition and immunity, the paths of infection, and the statistics of tuberculosis are next dealt with, after which a general account is given of the disease as it attacks various parts of the body.

The subjects of prognosis and general treatment are discussed, and the book ends with descriptions of tuberculin and sanatorium treatment and suggestions for the prevention of the disease. The author throughout avoids extremes, and when there is a difference of opinion both aspects of the question are stated. The book contains a large amount of up-to-date information, and is a very useful summary; it should appeal to a wide public. R. T. H.

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.*]

The West Indian Firefly.

THE writer is not in any sense an entomologist, but for this very reason his notes regarding this insect may have a certain interest as being from a different point of view from that usually taken. The beetle is much brighter than those with which we are familiar in the States and in England, and is always a source of interest to travellers. They first appear in Jamaica about the middle of February, and by the middle of June are found in great numbers, so that the fields as seen from a slight elevation sometimes appear strewn with wandering stars, much brighter than those in the heavens above. They are particularly numerous on damp or foggy evenings when there is no moon. Their light is constantly fluctuating, and the fluctuations occur more or less in unison over a considerable area, which makes their appearance much more striking. An individual light is readily seen at a distance of a quarter of a mile. They have powerful jaws, but nevertheless fall a ready prey to spiders, who consume them in large numbers.

The insect varies somewhat in size, but on the average measures 30 mm. (one and a fifth inches) in length, by 9 mm. in breadth, and is of a dark brown colour. Its system of lights is peculiar, and quite unlike the northern species. It carries a green light on either shoulder, and a much brighter orange light beneath the abdomen. This latter, however, is never shown except in flight, and at the very moment of leaving the ground. One often sees them flying along the side of a house, illuminating the eaves or clap-boarding with this bright orange light, much as a man might do it with a dark lantern, evidently looking for food.

When attacked by a spider their light glows intensely and continuously under the influence of the poison. If crushed, the light continues to glow long after the creature is dead, but it can be shut off at will. If held in the hand while the light is turned on, the insect gives out a perceptible warmth, and on enclosing one in a wine-glass with a thermometer bulb, the mercury was found to rise 1° F. the first minute. It rose another degree the second minute, and 0·6° in three minutes more. After this it slowly fell, although the light was still shining. Later, after the light had been extinguished, the thermometer returned to its original temperature, usually between 70° and 75°. Some fireflies are much more vigorous than others. With a weakly one the thermometer may not rise even as much as 1° in all. Two seem to be no more efficient in this respect than one.

The writer would like to have kept one a prisoner for twenty-four hours, weighing it at intervals, its loss of weight indicating the amount of its normal food consumption. Since its bulk, however, is but 0·7 of a cubic centimetre, its weight is about 0·7 of a gram, and its food consumption would be so small that it would require a delicate chemical balance to determine it with any accuracy. Such an instrument is not available here, so this investigation must be left to someone else. Presumably, however, it eats about as much as other beetles of the same size.

On account of its only showing its brightest light when in flight, its candle-power is rather difficult to determine. This was accomplished indirectly, however. A great number of them fly along a neighbouring road, and their position can be determined by their illumination of the enclosing stone walls. Their brightness was found to equal that of the star Canopus, which was just over the road, and at rather a low altitude. Its brightness was at that time equal to α Orionis, the altitude of which was 40°. It was a very clear evening, as is generally the case here, so that we may take the brightness of the latter as of 1·0 magnitude. The distance of the road was 175 ft., or 53 metres. A zero magnitude star is equal to one candle-power at 526 metres. If of zero magnitude the light of the firefly would therefore have been just 0·01 of a candle-power. Being of first magnitude, its light was 0·004 c.p. This result is probably correct within half a magnitude, or 50 per cent., and considering the apparent brilliancy of the insect is smaller than one would have expected. The writer is not aware of any previous measures of this quantity.

WILLIAM H. PICKERING.
Harvard Astronomical Station, Mandeville, Jamaica, B.W.I., March 22.

"Optical Glass" and Fluorite: An Ethical Note.

MR. F. J. CHESHIRE'S letter in NATURE of March 30 recalls the most exceptional character of the publication by Prof. Abbe and the firm of Zeiss of that discovery of apochromatism for which all must still be grateful. For the details I refer to the Journal of the Royal Microscopical Society, ser. 2, vols. vi., vii., 1886–7. An article in vol. vi., p. 315f, "The New Objectives," is evidently based on the letter of Prof. Abbe of March 4 (cited by Mr. Cheshire), for it contains precisely the same window-dressing statement that optical glasses hitherto in use only contain six chemical elements, while the new objective contains not fewer than fourteen. This article throughout conveys the impression that it has been alone the utilisa-

tion of new kinds of *glass* that has enabled Abbe to work out the conditions of practical apochromatism.

In the same volume, p. 848f, Zeiss's catalogue, "Neue Mikroskop-Objective und Okularen aus Specal-Gläzer des Glastenchnischen Laboratoriums" (Schott und Gen.), is reproduced "nearly *in extenso*." The same suggestion that only the new *glasses* are relied on is present throughout. Thus: "The objectives, however, like all productions of our firm, stand on an absolutely free basis. The glass employed is, by our own instrumentality, accessible to anyone, and no optician is in the least degree prevented from producing the same objectives as good and as cheap as he can." This is followed by extracts from the pamphlet by Abbe and Schott describing the new *glasses*, with their optical and other properties and prices. The abstractor seems by this time to have some suspicions as to whether scientific candour is not here tempered with commercial reticence, for he goes on:—

"Suggestions are made as to the glass best suited for various purposes, and on commencing the perusal of these passages we had the idea that we were coming to a description of the *glass* used for the new objectives. The following ingeniously worded paragraph, however, closes the subject.

"In the case of microscopic objectives which require for the attainment of the highest capacity of performance not only agreement in the course of the dispersion of the crown and the flint, but also the correction of the spherical aberration and its chromatic difference, it must be left to the skill of the practical optician to choose the most suitable means from the above series. The new objectives of Zeiss show what can be attained by their practical use."

We now pass to vol. vii., containing (p. 20f) a paper read before the Royal Microscopical Society on October 13, 1886, entitled "On Improvements in the Microscope with the Aid of *New Kinds of Optical Glass*." Its contents fully justify the title; throughout the same suggestion is made that the *glasses* are alone responsible for enabling the optician to attain the improvements connoted by the term apochromatism.

(I must state that the italics in the cited passages are all mine.)

Three comments will close this somewhat long letter:—

(1) Prof. Abbe, of Jena, was the brother-in-law of Carl Zeiss, the "practical optician" of Jena.

(2) It was soon discovered that one lens of fluorite (or fluorspar), the native fluoride of calcium, was an essential component of the apochromatic objective, as well as certain of the new glasses.

(3) Before the new lenses were placed on the market the house of Zeiss had, as they believed, secured the whole supply of colourless, flawless fluorite, suitable for optical purposes, which, like so many minerals, is restricted to few localities.

MARCUS HARTOG.

Cork, April 6.

PROF. HARTOG, in his "comments" Nos. 2 and 3, revives an old charge which was made by Mr. Lewis Wright in the *English Mechanic* (1892), pp. 220–221. Mr. Lewis Wright, in speaking of the use of fluorspar in the production of apochromatic objectives, there states:—

"Though some of them have managed to secure a little supply, others are painfully aware that before the use of fluorite was allowed to become public all the known available material had been secured by the firm of Zeiss at Jena; and the difficulty of getting material experienced by some of our best makers is a formidable obstacle to optical improvements and tends to artificially keep up the prices."

This charge was replied to and repudiated by Dr. Czapski, in a letter which appeared in the same volume of the *English Mechanic*, p. 287. Dr. Czapski in this letter states:—

"As regards fluorspar, Mr. Lewis Wright is labouring under a great delusion in assuming that before the use of fluorite was allowed to become public, all the known available material had been secured by the firm of Zeiss at Jena. The contrary may be said with more truth. The firm of Zeiss possessed but a very scanty supply at a time when, even previous to Mr. Koristka's groundless attacks in the *Journal de Micrographie*, the fact that fluorspar was being used in the apochromatic lenses had been published three times in consequence of information supplied by the firm of Zeiss.

"The latter were completely prepared to produce their future apochromatic lenses without having recourse to fluorspar, which by no means constitutes the condition *sine quâ non* for the production of apochromatic objectives, excepting, of course, in the case of such opticians who can only produce them by slavishly copying existing systems. As, however, the firm became eventually possessed of a considerable quantity of clear material, the employment of fluorite in their apochromatic lenses was continued."

The letters referred to above are reproduced in the Journal of the Royal Microscopical Society for 1892, pp. 552–555, from which the above quotations are taken.

I may be allowed to add that if Prof. Abbe and the firm of Carl Zeiss had wished to play the "dog-in-the-manger," they could easily have done so by taking out a patent for the application of the principle of apochromatic construction to microscope objectives. Prof. Abbe's "ethics," however, would not permit of this being done. He, I believe, held that since microscope objectives were practically entirely used for the purposes of scientific research, the taking out of a patent for them would have acted prejudicially to the best interests of science in general.

F. J. CHESHIRE.

The Remarkable Meteors of February 9, 1913.

THE large meteors which passed over Northern America on February 9, 1913, presented some unique features. The length of their observed flight was about 2600 miles, and they must have been moving in paths concentric, or nearly concentric, with the earth's surface, so that they temporarily formed new terrestrial satellites. Their height was about 42 miles, and in the Journal of the R.A.S. of Canada there are 70 pages occupied with the observations and deductions made from them by Prof. C. A. Chant.

The meteors were last seen from the Bermuda Islands, according to the descriptions in the journal named (May–June, 1913).

I have since made efforts to obtain further observations from seafaring men through the medium of the *Nautical Magazine*, and have succeeded in procuring data which prove that the meteors were observed during a course of 5500 miles from about lat. 51° N., long. 107° W., to lat. $5\frac{1}{2}$° S., long. $32\frac{1}{2}$° W.

Mr. W. W. Waddell, first mate of the s.s. *Newlands*, writes me that at 12.13 p.m., February 9, 1913, he saw a brilliant stream of meteors passing from the N.W. to the S.E. during a period of six minutes. The ship was in lat. 3° 20′ S. and long. 32° 30′ W. at the time. He says the meteors disappeared in the region of Argo to the south, and I have assumed they were over about lat. $5\frac{1}{2}$° S. and long. $32\frac{1}{2}$° W. when he lost sight of them.

Such an extended trajectory is without parallel in this branch of astronomy. Further reports from navigators in the South Atlantic Ocean might show that the observed flight was even greater than 5500 miles.

W. F. DENNING.

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FOREIGN WAR-PLANES.

AN article with the above title appears in *La Nature* of March 4, and is particularly interesting at the present time when British aeronautics is attracting so much attention. The article appears to have been written in fear of the Censor, and parts of it correspond more nearly with the end of last summer than the early part of the present year. The author refers to the belief, prevalent in France some little time ago, that British aviation was well ahead of their own, a belief widely held until, during the course of a single day, French aviators and gunners brought down seven battle-planes and a Zeppelin.

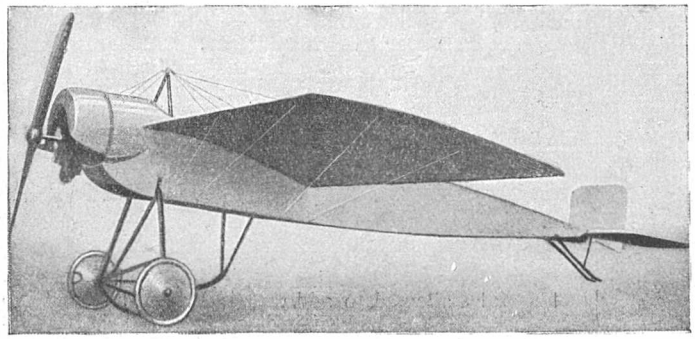

FIG. 1.—The Morane Sauliner.

Putting aside political manœuvres as of no importance, the author attempts to state the problems of aviation as they affect the engineer and constructor. Quite early in the course of his statement he concludes that the difficulties of flight would disappear, in peace-time, with the coming of a trustworthy light engine, but that for war purposes the problem is not so simple. A good war-plane must be strong and trustworthy; the observer must have a good field of view, particularly downwards, to assist reconnaissance and to make possible photography and bombing. In order to fight an enemy under favourable conditions, the zone of fire of the machine-gun must be as great as possible, and this implies a special shape of body. Finally, a convenient place must be found for bombs, and taken together the requirements are not easily satisfied.

As to speed, authorities differ, and there is again necessity for compromise, in this case between speed and weight-carrying. In France aeroplanes have mixed duties, whilst in England types differ more, are faster on the average than the French, but carry fewer bombs. The superiority of the Germans on speed is more apparent than real, their most recent and speedy aeroplane, the Fokker, being merely a copy of the Morane Sauliner. The similarity can be seen by a comparison of the two accompanying figures. The similarity is said to be complete almost in detail, and immediately after the Morane had been fitted with a safety device for firing through the propeller, the Fokker followed suit.

German aeroplanes are built in three distinct classes. To the first belong the scouts, mostly Albatross biplanes, which have largely supplanted the Taubes; fitted with Mercedes motors of 100 to 150 horse-power, these aeroplanes fly at from 70 to 90 miles per hour.

The second group of aeroplanes, fighters, are designed for attack and defence in the air. A new biplane (probably that known to British soldiers as "Fritz" or "Billy-two-bodies") with two bodies and central car for the machine-gun belongs to this group. Its two engines each develop 250 horse-power. The Fokker, capable of 60 to 100 miles per hour, is also one of the fighter-type aeroplanes.

The third group of German aeroplanes is intended for reconnaissance. The machines all carry wireless apparatus, and act as spotters for artillery.

Following a very brief and unsatisfactory survey of British, American, and Italian aeroplanes is a discussion of French aviation. Contrasting aviation with gunnery, the author cites the latter as an instance of an art based on scientific knowledge, whilst it is said that until an aeroplane has been made and tested it is not possible to form any trustworthy estimate of its speed, stability, or sensitiveness to controls. The defect is more important, as aviation has not any traditions; its development has been left to private enterprise, and up to the present without any indication of the end to be attained. The result has been to stimulate competition between constructors without collaboration. If such a picture of the position of French aeronautics is even approximately true, it is difficult to believe that Britain has yet lost her superiority in the domain of design and construction.

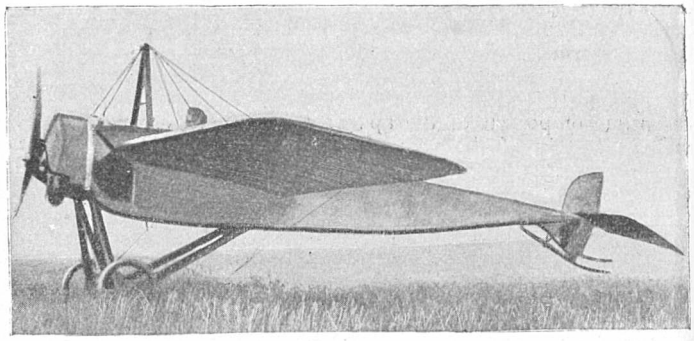

FIG. 2.—The German Fokker.

THE DAYLIGHT SAVING SCHEME.

CONSIDERATION is again being given to the principle of ensuring the utilisation of a larger number of hours of daylight in the summer months by putting forward the hands of timepieces by one hour during a period made compulsory by legislation. It was announced a few days ago that, by order of the Federal Council in Germany, all clocks there will be put forward an hour at 11 p.m. on April 30, and put back an hour at 1 a.m. on October 1. The French Chamber of Deputies has voted unanimously for a similar proposal, and a committee of the Senate has been appointed to consider it. Also, the Home Secretary stated in the House of Commons on April 17 that the question of taking the same step here is receiving the attention of the Government.

It is possible that the committee of the French Senate will report against the adoption of the proposed alteration of standard time; and substantial reasons for doing so can be found in a critical survey of the whole subject presented to the Paris Academy of Sciences, on April 10, by M. Ch. Lallemand. The supposed advantages of the daylight saving scheme are examined and criticised, and the conclusion reached is strongly adverse to the proposed change. It is shown that many of the advantages claimed are illusory. In France more than four-fifths of the population in the open country and smaller towns regulate their habits by the sun rather than by the clock; foundries and factories running continuously over the twenty-four hours would be unaffected. On the other hand, the advantages of such a scheme have already been realised in a simpler manner in French schools, colleges, and barracks, where it has been customary for a long time to rise one hour earlier in the summer.

We have dealt with the daylight saving principle on many occasions and have stated the fundamental objections to it. The scheme originated with the late Mr. W. Willett; and his persistent advocacy of it led to the introduction of a Daylight Saving Bill in the House of Commons in 1908. The Bill passed its second reading and was reported on favourably by a Select Committee, but it failed to reach the final stages in the House. It was re-introduced in the following year, when a Select Committee reported against it, and again it failed to pass. In 1911 the scheme was once more brought before the House under the title of the Summer Season Time Bill, only to be dropped at the end of the session. This Bill provided that "Greenwich mean time, as used for the purposes of astronomy and navigation, shall not be affected"; but otherwise the legal times of the United Kingdom of Great Britain and Ireland were to be advanced by one hour on the third Sunday in April in each year and put back by the same amount on the third Sunday in September. Every spring since then the advocates of this legislative measure have renewed their activities in the Press; and this year the circumstances of the war have given them an exceptional opportunity of stating their argument that great saving in fuel used for lighting would be effected by making the daylight saving scheme compulsory.

We do not propose to attempt again to explain why the scheme is fundamentally unsound and scientifically undesirable, but it may be worth while to state categorically some of the main objections to it. These are as follows:

(1) A very large part of the population of our islands already makes full use of the daylight available in the different seasons, by adapting their hours of work to the hours of daylight. This is the case in all agricultural districts, and also in the building, engineering, and other trades which cannot be carried on easily in artificial light. The proposed Act of Parliament would thus not effect any daylight saving in these occupations; and wherever artificial illumination is easy and convenient, working hours will always tend to be independent of the position of the sun.

(2) Practically all the civilised nations of the world use a system of time-reckoning based upon the Greenwich meridian, their times being so many hours or half-hours behind or in advance of Greenwich time. If a periodical change of the time-standards in various months by different countries became the fashion, chaos would take the place of the present orderly system. There would be a kind of game of general post at certain periods of the year, each nation taking the time of its next eastern neighbour. Our prime meridian, accepted by nations as regulating the time of the world, would be discarded by us for five months in every year, in total disregard of existing well-considered and well-established international relations.

(3) The scheme would be applied to the whole of Great Britain, though north of Edinburgh there is little real darkness for a couple of months in the summer. All places north of Edinburgh have twilight all night from the end of April to the end of July, and there would be no advantage whatever in calling nine o'clock ten during those months. When the effect of latitude upon the length of day is considered, little support can be found for including Scotland in the scheme. On account of difference of latitude, Scotland has already a natural extension of the daylight hours in the summer months without any need for legislation.

(4) The duration of daylight in the third week of April is quite different from that of the third week in September. The corresponding parts of the year as regards length of day are the third week of April and the third week of August, or the third week of March and the third week of September.

(5) As Greenwich mean time would continue to be used for times of sunrise, sunset, moonrise, lunar changes, tides, and other phenomena of astronomy and navigation recorded in calendars and tables, the difference between this and clock-

time would often lead to great confusion. Boat-trains would run according to the mid-European time, but the tides would be stated in Greenwich mean time. In most seaport towns a time-signal is used for the convenience of vessels in port, and is also valuable to the public. Would the signal always be given according to Greenwich mean time, or would it mark the changed hour during certain months of the year? It would often be difficult for local bodies to decide whether the interests of navigators or those of the public ought to determine the hour at which the time-signal should be given. Lighting-up times would be in like confusion, for they are determined by the times of sunset, which belong to astronomy, whereas the times in use would be those of the Greenwich or mid-European meridians according to the period of the year.

(6) Artisans who have to be in workshops at 6 a.m. would begin work at what is really 5 a.m., and therefore most of them would have to rise at about 4 a.m. This means that they would have to get up in the dark more than twice as often under the daylight saving scheme as they do now. The difference would be particularly noticed in the last month of the period. The six o'clock artisans would have to suffer the discomforts of additional darkness in the early morning in order that people who are asleep when they have done a quarter of a day's work may have additional daylight at the other end of the day.

(7) For several weeks of the period over which the proposed advance of time would be effective additional fuel would be consumed for heating in the early morning, and this amount, as well as the additional lighting required by many thousands of artisans getting up in the dark, is overlooked when the saving of artificial illumination at night is put forward as a plea for the adoption of the scheme. The heat meridian is about two hours after the light meridian; and possibly it has determined the customary time-table here, as it does the social arrangements of other countries of Europe, as well as in the Tropics.

(8) Though hundreds of corporations and councils have expressed their desire to have the 154 additional hours of daylight per annum promised by the scheme, not a single scientific society or other body with expert knowledge has supported it. The public may demand whatever legislation it pleases, without regard for the consequences; but, in the words of the Select Committee which reported upon the Daylight Saving Bill of 1909, "having regard to the great diversity of opinion upon the proposals of the Bill and to the grave doubts which have been expressed as to whether the objects of the measure can be attained by legislation without giving rise, in cases involving important interests, to serious inconvenience," it will be a pity if the circumstances of the war should lead Parliament to adopt a measure which has been twice rejected already after full discussion.

THE IMPERIAL INSTITUTE.

THE Imperial Institute (Management) Bill, which received the Royal Assent on April 18, provides for the transfer of the property and management of the Imperial Institute from the Board of Trade (in which these were vested by the Act of 1902) to the Colonial Office. Mr. Bonar Law, in a speech on the second reading in the House of Commons, explained that in view of the commercial reorganisation which would take place after the war the Government desired that the valuable work of the institute should be supported by a larger and more representative governing body, on which each of the Dominions, India, and the Crown Colonies would be represented, as well as the Colonial Office, the Board of Trade, the Board of Agriculture, and the India Office, whilst representatives of the commerce and industry of the United Kingdom would also be nominated on the executive council, which will consist of twenty-five members. Among the speakers at this stage, and afterwards in Committee, were Sir J. D. Rees, Sir John Jardine, and Colonel Yate, all of whom proposed increased representation of India, and Sir Philip Magnus, who asked for the appointment of representatives both of the Imperial College of Science and Technology and of the University of London.

It was announced that the member selected by the Committee of the Privy Council for Scientific and Industrial Research would be nominated by the Secretary of State for the Colonies, and that of the other nominees of the Secretary of State one would be an Indian member in addition to Lord Islington, the Under-Secretary of State for India, which would give India five members in all.

The second reading of the Bill in the House of Lords was moved by Lord Islington, who fully explained the intentions of the Bill and spoke in high terms of the value of the work of the institute to the commerce of the Empire. Viscount Milner supported the Bill, and expressed the hope that in future the institute would be better supported with funds to aid the extension of its important work, a view which was also expressed by Viscount Peel and Lord Sudeley. In Committee Lord Sudeley moved an amendment to make Ministers of the Dominions, Governors of Crown Colonies and Protectorates, and members of the Viceroy's Council in India when at home on leave, *ex-officio* members of the executive council. This was not accepted by the Government, who, however, agreed to invite the persons specified to attend the meetings of the executive council.

THE SUN'S ROTATION.[1]

AN interesting contribution to the investigation of the sun's rotation by the spectroscopic method has been made by Mr. J. B. Hubrecht in an extended discussion of a series of plates taken by him with the McClean equipment at

[1] Annals of the Solar Physics Observatory, Cambridge. Vol. iii., Part i. The Solar Rotation in June, 1911, from Spectrographic Observations made with the McClean Solar Instruments. By J. B. Hubrecht. Pp. 77. (Cambridge: At the University Press, 1915.) Price 9s. net.

Cambridge in June, 1911. The photographs in question are unique, inasmuch as in place of the usual comparisons at opposite points of the limb, they compare the spectra at points 90° apart, at intervals of 15° completely round the sun. By this arrangement the velocities in the two hemispheres may be separately derived, and Mr. Hubrecht concludes that at the period of these observations the velocities were greatest in the northern hemisphere. Thirty lines, belonging to seven elements, and including four enhanced lines, were measured, and no departure from average results was found for any of them. There was, however, a distinct diminution of the indicated velocity with increase of wave-length, for which no definite explanation can yet be given. In relation to heliographic latitude, the results are remarkable as showing uniform angular velocity from 15° N. to 15° S., and, following the usual decline to higher latitudes, a slight increase between latitudes 60° and 75°. The deduced angular velocities as a whole are also considerably smaller than those derived at Mt. Wilson, and the equatorial velocity is assigned the correspondingly low value of 1·85 km. per second.

These departures from the average results of other observers were constant throughout the period of observation, and there is evidence that they were not due to local disturbances; Mr. Hubrecht appears to regard them as possibly associated with temporary conditions in the sun, and believes that his results are consistent with Emden's theory.

A somewhat remarkable feature of Mr. Hubrecht's memoir is its appearance as vol. iii., part i., of the Annals of the Solar Physics Observatory, Cambridge, since it refers to data obtained before the transfer of the Solar Physics Observatory from South Kensington, and discussed after the author had left Cambridge. Vols. i. and ii. of these Annals have not yet been issued, and we have been unable to ascertain what their contents will be.

NOTES.

WE learn with much satisfaction that the announcement of the death of Prof. I. P. Pavlov is incorrect; and we may hope, therefore, that the record of his work given in NATURE of March 2 will be extended still further in the coming years. Prof. B. Menschutkin, of the Polytechnic Institute, Petrograd, writing on March 20, informs us that Prof. Pavlov is alive and well, and that the Prof. Pavlov who died in February was Eugeni Vasilievitch Pavlov, a celebrated surgeon. The name of Pavlov is common in Russia, there being no fewer than five professors of that name in Petrograd, so that the mistake in the *Times* of February 12 is quite comprehensible.

THE death is announced, at Ottawa, of Dr. W. F. King, chief astronomer, Department of the Interior, Canada, and director of the Dominion Astronomical Observatory; also of the Rev. J. B. McClellan, formerly principal of the Royal Agricultural College, Cirencester.

THE bronze tablet placed in St. Paul's Cathedral to the memory of Captain Scott and his companions will be unveiled by the Prime Minister on Friday, May 5.

A CONFERENCE on engineering and scientific research will be held at Caxton Hall, Westminster, on Monday next, May 1, at 5 p.m. The conference will be opened by Prof. J. A. Fleming, and a number of leading representatives of engineering science are expected to take part in the discussion.

HIS EXCELLENCY LORD CARMICHAEL has accepted the chairmanship of the trustees of the Indian Museum for the year 1916–17. The Hon. Justice Sir Asutosh Mookerjee has been elected vice-chairman, and the Hon. Raja Rishe Case Law honorary treasurer.

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1915–16:—A Telford gold medal to Sir John Benton (Eastbourne); a Watt gold medal to Sir George Buchanan (Rangoon); a George Stephenson gold medal to Mr. F. W. Carter (Rugby); and Telford premiums to Mr. C. Carkeet James (London), Mr. D. E. Lloyd-Davies (Cape Town), and Mr. W. T. Lucy (Oxford).

WE learn with regret that Mr. C. Lees Curties, late partner in the well-known firm of Charles Baker, High Holborn, London, W.C., scientific instrument manufacturer and agent, died on April 24, at fifty-five years of age. We are informed that the business will be carried on as usual, under the same title, by the remaining partners—Mr. T. Hale Curties and Mr. C. Lees Curties, jun.

THE President of the Board of Trade has appointed a Committee to control the supply and distribution of petrol, and to consider what measures are necessary in the national interest (1) to ensure that adequate supplies of petrol shall be available for the purposes of the war and for other essential needs; (2) with the above object to regulate the use of petrol for other purposes in the United Kingdom during the period of the war; and, subject to the direction of the Board of Trade, to give executive effect to the measures decided on. The Committee consists of Mr. O. Bury (chairman), Mr. A. E. Bowen, Sir John P. Hewett, and Mr. P. G. L. Webb. Mr. H. W. Cole, of the Board of Trade, will act as secretary to the Committee.

THE President of the Board of Trade has appointed two further Committees to consider the position of certain branches of British trade after the war, with special reference to international competition, and to report what steps, if any, are necessary or desirable in order to safeguard that position. These Committees are:—*For the Textile Industries*:—Mr. Henry Birchenough (chairman), Sir F. Forbes Adam, Mr. J. Beattie, Mr. T. Craig Brown, Mr. E. B. Fielder, Mr. J. W. Hill, Mr. A. Illingworth, Mr. J. H. Kaye, Mr. E. H. Langdon, Mr. J. W. McConnel, Mr. H. Norman Rae, Sir Frederick Smith, Bart., Mr. T. C. Taylor, Right Hon. Robert Thompson, Mr. F. Warner. Mr. T. M. Ainscough will act as secretary to the Committee, and all communications relating to it should be addressed to him at 6 Whitehall Gardens, S.W. *For the Electrical Trades*:—Hon. Sir Charles A. Parsons (chairman), Mr. J. Annan Bryce, Mr. T. O. Callender, Mr. J. Devonshire, Mr. B. M. Drake, Sir John Snell. All communications should be addressed to the secretary, Electrical Trades Committee, at 7 Whitehall Gardens, S.W.

THE tragic death of Major W. L. Hawksley, R.A.M.C., whilst on active service in France, removes from the service of the Liverpool Corporation a bril-

liant assistant medical officer. Dr. Hawksley had always been associated with Liverpool, and was a graduate of the University of the city. His first association with the corporation was as a resident medical officer at the Fazakerley Hospital. Afterwards he held the post of assistant school medical officer, and ultimately was appointed an assistant medical officer of health to deal with problems relating to tuberculosis. Following the passing of the National Insurance Act, Dr. Hawksley naturally attained the additional position of acting chief tuberculosis officer, a post for which his previous experience gave him exceptional qualification. The harmonious relationship which now exists between the Insurance Committee and the corporation serves as a lasting monument to his unfailing tact and administrative ability, for upon his shoulders fell much of the original work of organising the Liverpool tuberculosis scheme. Of his services to his country since war was declared little is known to those at home, but, if his military duties were performed with the enthusiasm, tact, and efficiency which characterised his work as a civil servant, the loss to the Army is as deplorable as to the city of Liverpool. His interests were many-sided, for, besides the numerous committees of charitable organisations on which he served, the Atmospheric Pollution Committee has reason to feel the loss of an enthusiastic worker. All who knew Dr. Hawksley will deeply sympathise with his widow and two children in their bereavement.

THE *Daily Chronicle* for April 24 gives the substance of an interesting letter sent to Prof. Lorentz, of Haarlem, by Dr. Max Planck, professor of mathematical physics in the University of Berlin, and permanent secretary of the Royal Prussian Academy of Sciences. In this letter Prof. Planck recalls the letter addressed to the civilised world in August, 1914, by ninety-three German scholars and artists, in which they defended the conduct of their own Government, and denounced in extravagant language the action of the Allies. Prof. Planck himself was one of the signatories. He now admits that the form in which this letter was written led to regrettable misunderstandings of the real sentiments of the signatories. In his opinion, and it is an opinion shared, he says, by his colleagues Harnack, Nernst, Waldeyer, and Wilamowitz-Möllendorff, that letter of appeal was written and signed in the patriotic exuberance of the first weeks of the war. It must not be taken for granted, says Prof. Planck, that at the present time anything like a scientific judgment can be formed with regard to the great questions of the historical present. "But what I wish to impress on you," he writes to Dr. Lorentz, "is that notwithstanding the awful events around us I have come to the firm conviction that there are moral and intellectual regions which lie beyond this war of nations, and that honourable co-operation, the cultivation of international values, and personal respect for the citizens of an enemy State are perfectly compatible with glowing love and intense work for one's own country."

ACCORDING to the *Times* of April 20, the Behar and Orissa Government has issued an account of recent unrest among the Oraons of Chota Nagpur, which is of considerable interest to anthropologists. The unrest would seem to have been brought about by a number of causes, among them a desire to raise the tribe to the higher social level of Hindu and Christian converts, the general unrest caused by the war, and the withdrawal of German missionaries. The chief cause, however, would appear to be an effort made by the Oraons about August, 1915, to expel from their country the evil spirits which they held responsible for the bad crops and the high prices. To effect this object secret meetings were held at night by the younger men, at which powerful *mantras,* or spells, were recited. Into some of these, it is not unimportant to note, the name of the German Emperor was introduced. Acts of violence followed, and extra police were drafted into the district. But, adds the report, the process of pacification is slow, as the expulsion of evil spirits from one village leads to the alleged transfer to another. As might have been expected, the movement was followed by "witch-hunting," in which the general populace took part, as well as the *sokas,* or "witch-hunters." Several murders have taken place. The whole account is an interesting commentary on primitive psychology, with the workings of which readers of Sir James Frazer's discussions of the purification ceremony of "devil-driving," the transference of evils, and the medicine-man will be familiar. It may also serve as a further reminder, should one be needed, of the importance to officials of an understanding of the springs of action in a lower race.

IN the recently issued annual report of the Decimal Association for 1915, it is stated that the past year has shown a distinct advance in public opinion in favour of the compulsory introduction of the metric system of weights and measures. It is pointed out that our manufacturers are severely handicapped as regards trade with foreign countries by the retention of our present weights and measures. As the metric system is in use in the majority of foreign markets the British manufacturer who wishes to introduce his goods into those markets is at present obliged to maintain two systems of weights and measures, both in his works and in his office. On the other hand, his competitor on the Continent employs only one system throughout, and that system is understood both by the middleman and the customer. One of the results of the war has been to familiarise the nation with the metric system to a remarkable extent. The presence of our soldiers on the Continent and of Belgian and French refugees in our midst has been an important factor in bringing this about. The nation has already had to experience so many drastic innovations that a reform of our weights and measures would not now meet with that blind opposition from the general trading community which up to the present has been apprehended by the authorities. The inconvenience experienced by the public owing to the exclusion of German and Austrian wares, especially certain classes of goods which have become almost necessaries, must have caused the nation to realise that improvement in our business methods is urgently required. The Association hopes that the Government will take advantage of the favourable opportunity which war conditions have created for introducing legislation to bring our weights and measures into conformity with those which have been proved by our competitors to be the most suitable for stimulating external trade.

THE address of Sir Hugh Bell to the members of the Political Economy Club on March 1, published in the *Economic Journal* for April, is a valuable contribution, especially as coming from a great iron-master in close competition with a great German industry, to the current controversy as to the commercial policy of this country after the war in relation to the Central Powers. Sir Hugh Bell makes it clear that the industrial advance of Germany since 1870 has been the fruit mainly of "the German system of education," which "put into the hands of the German manufacturer the means of conducting his operations in a thoroughly scientific way." "Very carefully trained chemists were turned out of the technical schools by hundreds," and the manufacturers "had the good sense to make use of the materials thus pro-

vided." "The field of inquiry was quite new, and offered boundless opportunities of research," and it was vigorously exploited, with the result which the war has made only too plainly evident. Alluding to the manufacture of dyes, regret is expressed that a great new branch of industry has passed from British control, but in this matter blame is laid upon the Government, both central and local, in the enactment of unwise restrictions, the effect of which, as, for example, in the instance of alcohol, has resulted in the serious hampering of industrial development. The great industrial prosperity of the country has also produced an attitude of indifference to scientific discovery in this and other countries, which, in the case of the latter, has silently but none the less surely laid the foundation of great industrial enterprises. "There has never been," says Sir Hugh Bell, "during the last fifty years a time of any duration when it would have been possible to get 10,000 capable workmen to take up new work. There have been plenty of unemployed, but they were persons who, under the conditions existing, were unemployable." There could scarcely be a more eloquent testimony to the need, or a more adequate spur, for a better organised scheme of education by means of which we could create a great reservoir of rightly educated men. We need the vision without which a nation must perish.

THE Cuzco valley in southern Peru has become known for its vertebrate remains embedded in comparatively recent gravels (see NATURE, vol. lxxxix., p. 584, and vol. xci., p. 615). The Yale expedition was mainly concerned with the antiquity of man, but Mr. H. E. Gregory was enabled to extend his researches to the geology of the valley and its relation to the Andean chain. In the *American Journal of Science*, vol. xli. (1916), p. 19, he presents a new conception of the Andes as an uplifted plateau of continental and marine sediments penetrated by igneous intrusions, the surface of erosion having little regard to geological structure. The deep dissection of this late Mesozoic surface has cut "a number of canyons rivalling the Grand Canyon of the Colorado in depth and ruggedness." The Urubamba has trenched the plateau to a depth of more than 5000 ft. The Cuzco valley is an incident of the plateau, where faulting has helped to produce a depression, in the upper part of which a lake was at one time formed by downwarp.

IN the interior of Borneo much exploration remains to be done. Mr. J. C. Moulton, Curator of the Sarawak Museum, has put together an account of the various expeditions to Mount Kinabalu, British North Borneo, from 1851 to his own expedition in 1913 (*Sarawak Museum Journal*, vol. ii., pt. ii., September, 1915). The article is accompanied by a map showing the best routes to the mountain, and contains a good deal of new information, much of it collected from native sources. The same number of the Journal contains a number of valuable articles on the natural history, botany, and zoology of Borneo.

FURTHER evidence that some at least of our British swallows (*Hirundo rustica*) winter normally in the extreme south-east of Africa has come to light by the recovery, near Grahamstown, on February 6, 1916, of a bird which was ringed by Mr. F. W. Sherwood at Lytham, Lancashire, on July 3, 1915. This, remarks Mr. H. F. Witherby, in *British Birds* for April, is the third swallow which has been reported from South Africa similarly marked for identification. The first was ringed as an adult at Rosehill, Cheadle, Staffordshire, on May 6, 1911, and was caught on a farm near Utrecht, Natal, on December 27, 1912. The second was ringed as a nestling at Skelmorlie, Ayrshire, on July 27, 1912, and was caught at Riet Valley, Orange Free State, on March 16, 1913.

SOME useful work on Indian Cestoda, by Mr. T. Southwell, appears in the Records of the Indian Museum, vol. vii., part 1, 1916. The author describes a number of species found in Indian fishes, birds, and mammals. He confines his remarks to the anatomical characters of adults. The larval stages, indeed, of many of the species herein surveyed are unknown. More particulars in regard to the hosts of these parasites would be acceptable. Where information on this head is lacking it would be of distinct advantage to say so. The same issue contains a paper by Major R. E. Lloyd and Dr. N. Annandale on the brackish-water hydrozoon, *Campanulina ceylonensis*. The authors have been enabled to work out the complete life-history of this interesting species, and thereby they have discovered that the form described by Browne under the name *Irene palkensis* is really but a senile stage of *ceylonensis*.

KEW BULLETIN, No. 1 for 1916, contains a useful paper on the African species of the genus Morinda (Rubiaceæ) by Mr. S. Hutchinson. Four species are now recognised, a new one, *M. confusa*, being described in the paper. Owing to the excellent material sent home by Mr. Lane-Poole, Conservator of Forests, Sierra Leone, the country inhabited by three of the species, it has been possible to draw up careful diagnoses. The fourth species, *M. lucida*, Benth., is not known further north than the Gold Coast. The Sierra Leone species are found in the rain forests of the colony. The species are used medicinally for various purposes, but especially for fever, *M. geminata* having a reputation as being efficacious in cases of yellow fever. The distinctive characters of the four species are well shown in a series of text figures.

AN important memoir on the Avezzano earthquake of January 13, 1915, has been communicated by Prof. E. Oddone to the Italian Seismological Society (*Bollettino*, vol. xix., 1915, pp. 71–215). On the small-scale map which illustrates the paper, the isoseismal lines of the epicentral area are shown, the intensity being determined by reference to the Cancani duodecimal scale. In this district there are two chief areas of destruction. The northern area, in which the intensity of the shock reached the degree 12, lies in the basin formerly occupied by the lake of Fucino, and extends from the neighbourhood of Avezzano to that of Lecce. The southern area, in which the intensity was usually 10, but in places 11, lies along the Val Liri. Prof. Oddone attributes the remarkable variations of intensity in the epicentral district mainly to orographic and geological conditions, and not to the existence of separate centres of disturbance. The directions of the movement diverge from an epicentral area a few kilometres in length and elongated from north-west to south-east, the centre of the area being in 41° 58′ N. latitude, 13° 36′ E. longitude, or about 16 km. to the south-east of Avezzano. The ground in this district is broken up by numerous fissures, the most remarkable of which is a perimetral crack, following approximately the course of the isoseismal 12. The crack, which has been traced almost uninterruptedly for 70 km., is usually from 30 to 100 cm. in width, the ground within it (that is, towards the Fucino) being depressed relatively by 30 to 90 cm. The duration of the earthquake, scarcely exceeding five seconds, was one of the shortest of known destructive earthquakes. Prof. Oddone estimates the depth of the focus at approximately 10 km.

THE existence of reindeer in Spitsbergen has never been satisfactorily explained, and is a vexed problem

in geographical distribution. M. Adolf Hoel has a paper on the subject in *La Geographie* for December, 1915 (vol. xxx., p. 6). His contention that the Spitsbergen reindeer have come from Novaya Zemlya *viâ* Franz Josef Land is supported by a single piece of evidence, but a very strong one. In 1912 an old male reindeer was shot in Spitsbergen that had attached to one of its horns by a piece of cord the foot of an ivory gull. It also had incisions on its ears. There can be no doubt that these markings on the horn and ears were the work of Samoyedes on Novaya Zemlya, who are accustomed to distinguish certain members of their herds in this way. Other reindeer with marked ears are said, but on less secure evidence, to have been shot in Spitsbergen. In any case, this particular deer was not brought from Novaya Zemlya by man. From Novaya Zemlya to Franz Josef Land is about 240 miles, from Franz Josef Land to King Carl Land about 210, and to Edge Island, Spitsbergen, another 55 miles. Winter ice would certainly permit such a journey, but the difficulty is to believe that a reindeer could travel 240 miles without food. However, M. Hoel's explanation seems the only possible one. A passage direct from Lapland to Spitsbergen would be impossible, if only because there is never continuous ice.

PART 2 of vol. xxviii. of the Proceedings of the Physical Society of London contains thirty pages, twenty of which are devoted to the Guthrie Lecture delivered at the end of January by Dr. W. B. Hardy, secretary of the Royal Society. He chose for his subject some of the physical problems raised by the study of living matter. He showed, for example, how the growth of the severed end of a nerve towards its corresponding end is determined by small differences of concentration of some substance diffusing out from the severed ends. The phenomena of growth depend on the presence of minute quantities of substances known as vitamines, often found exclusively in the rinds or skins of grains and fruits, and Dr. Hardy drew a parallel between their action in determining growth and the effect of throwing a few crystals into a supersaturated solution. The remainder of the part is devoted to a short paper by Prof. Lees on a generalised bridge for the comparison of the self and mutual inductances of two coils, and another by Dr. Sand on a cadmium arc lamp similar in principle to the mercury arc lamp.

IN 1911 a paper was read before the International Photometric Commission by W. J. A. Butterfield, J. S. Haldane, and A. P. Trotter, describing some careful experiments on the Pentane and Hefner standard lamps. By enclosing these lamps in a special chamber the effect on the light of carbon dioxide, aqueous vapour, and barometric pressure could be conveniently studied; with the great advantage that variations far greater than those met with in practice could be produced, and the resultant changes in candle-power studied on a large scale. In the case of the Pentane lamp the results obtained were in close agreement with those previously reported by C. C. Paterson at the National Physical Laboratory. But the correction for the effect of carbon dioxide and change in barometric pressure on the Hefner lamp were found to be respectively three times and four times that previously assumed by Liebenthal. This question has since been studied by Dr. Ott, of Zurich. With the view of securing exceptional variations in barometric pressure experiments were first made at various stations in high altitudes, but eventually the method of employing a compression chamber was adopted. A change of barometric pressure from 816 to 717 mm., which is the most important range from a practical viewpoint, produced a variation in the candlepower of the Hefner lamp of only 1·1 per cent. This is in close agreement with Liebenthal's formula. But from 717 mm. to 614·5 mm. the variation in candle-power was found to be much greater, and the average effect for the entire range of 816–614·5 mm. approximated very closely to the figure given by Butterfield, Haldane, and Trotter. As regards the effect of carbon dioxide Dr. Ott agrees with these observers in finding the factor given in Liebenthal's formula too small, but this arises from the fact that the presence of much carbon dioxide is in practice usually due to the vitiation of the air of the photometer room. The light is thus affected by deficiency of oxygen as well as the carbon dioxide. Well-ventilated and sufficiently large rooms are therefore essential for standard work.

THE accurate measurement of the vapour pressure of ice at low temperatures is a problem of considerable difficulty, not only on account of the smallness of the values involved, but also because of the adsorption on glass surfaces and of the thermal molecular pressure. These difficulties appear to have been overcome in a very satisfactory manner by S. Weber (*Kgl. Danske Videnskabernes Selskabs Forhandlinger*, No. 6, 1915, Copenhagen). The pressure, down to 205° absolute, was measured by means of the loss of heat from a hot Wollaston wire, and below this temperature by Knudsen's absolute manometer. It was also checked more roughly by means of a mercurial manometer with optical contacts, reading to 3μ. The residual pressure in the apparatus at 143–163° abs. was 0·053–0·070 dyne per square centimetre for ice from conductivity water, and about half this for ice prepared inside the apparatus from pure hydrogen and oxygen. After correcting for this residuum, which is unaccounted for, an extremely good agreement with Nernst's empirical formula was obtained, down to 175° abs. The same number of the above Journal contains the fifth of a series of papers by C. Christiansen on the frictional electricity generated by drops of a liquid falling on a platinum plate. The effect is much greater for solutions of non-electrolytes (mercuric cyanide, triamminocobaltinitrite) than for those of electrolytes (mercuric chloride, hexamminocobaltichloride).

IN a paper entitled "Theory and Practice in the Filtration of Water," read to the Institution of Mechanical Engineers on April 14, Mr. W. Clemence attempts to prove that the multiple filtration process invented by MM. Puech and Chabal is economically and hygienically the most efficient process of water purification. The process consists of passing the water through a series of filters filled with material ranging from coarse gravel in the first to fine sand in the last, the greater part of the suspended matter in the water being retained by the earlier elements, so that no film forms on the surface of the final sand filter, the work of purification being effected by nitrifying organisms in the body of the sand, thus differing from other processes, which depend largely on the straining effect of a surface film formed by natural or artificial means. While making the best case he can for the multiple process—and on the whole a good case—the author scarcely does justice either to mechanical or ordinary slow sand filtration. Most water experts now agree that these latter processes cannot be taken as the "only line of defence" against water-borne disease, but with an initially "safe" water the improvement in appearance and the removal of oxidisable matter effected particularly by mechanical filters are often most marked. On the other hand, it is claimed that the multiple process is capable of rendering safe an

unsafe water, although no conclusive evidence in the way of figures is brought forward to prove it. Indeed, throughout the paper, which gives in considerable detail the results of tests made on multiple filtration plants in different parts of the world, there is no mention of any tests being made for *B. coli*.

THE Health of Munition Workers' Committee has issued a memorandum on special industrial diseases in which it is stated that the work of certain industrial processes entails risk of serious, and possibly fatal, illness from exposure to lead, ethane tetrachloride, nitrous fumes, and certain explosives, whilst contact with trinitrotoluol, tetryl, mercury fulminate, and certain lubricating and cooling liquids used in metal turning may produce dermatitis. The provision of facilities for the prompt treatment of all cases of sickness and injury is recommended. Operatives engaged in manufacturing or handling trinitrotoluol have been found affected with unusual drowsiness, frontal headache, eczema, and loss of appetite. The symptoms are generally slight at first, and disappear when exposure ceases, but in exceptional cases sudden collapse may occur after a few hours' work on a hot day. The symptoms are intensified by continued exposure, and in a few cases profound jaundice and even death have resulted. T.N.T. may be absorbed by the lungs, skin, or digestive tract, in the form of vapour or dust, and certain preventive measures are specified.

BULLETIN No. 266 of the Scientific Papers of the Bureau of Standards, by Messrs. Cain, Schramm, and Cleaves, deals with the preparation of pure iron and iron-carbon alloys. The authors have worked out methods of producing laboratory samples of iron-carbon alloys of a very high degree of purity; sources of contamination of melts and means of eliminating them are described; a method of preparing magnesia of a satisfactory degree of purity for making crucibles to be used in work of this kind has been developed; and a procedure for making small ingots, which are sound and free from blowholes, without the use of deoxidisers, has been worked out. A series of iron-carbon alloys containing 99·96 per cent. of the two elements has been prepared to serve as a basis for the redetermination of the iron-carbon equilibrium diagram.

IN Bulletin No. 60 of the Technological Papers of the U.S. Bureau of Standards, H. S. Rawdon describes the microstructural changes accompanying the annealing of cast bronze (Cu_{88}, Sn_{10}, Zn_2). The alloy is first brought into physico-chemical equilibrium. The dendritic structure persists until heated for approximately two hours at 800° C. The absorption of the eutectoid depends much on how the sample cooled on freezing. No evidence was found suggesting a change of crystal size of cast samples which had not been distorted in any way. Recrystallisation, including twinning, was found only to follow distortion or its equivalent. Metal cooled suddenly from the molten state behaves similarly because of the high internal stresses resulting.

MESSRS. CASSELL AND CO., LTD., have ready for publication "Alfred Russel Wallace: Letters and Reminiscences," by J. Marchant. The volume will contain a number of hitherto unpublished letters, reminiscences from various friends, and a sketch (from his son and daughter) of Dr. Wallace's home life. The evolution of the idea of natural selection is traced up to the time when the papers on the subject by Darwin and Wallace were communicated to the Linnean Society, and Dr. Wallace's other scientific work is dealt with in the volume.

OUR ASTRONOMICAL COLUMN.

THE PLANET MERCURY.—This planet will be at greatest E. elongation on May 12, 21° 36′ E. from the sun. It will continue above the horizon about two hours after sunset. Maximum conspicuousness occurs several days *before* the elongation.

COMET 1916*a* (NEUJMIN).—Observations, including an arc of thirty-seven days (February 27–April 4), have been employed by M. J. Braae in calculating a new orbit for this comet. The second and third places are based on observations made at Bamberg (March 23) and Neu Babelsberg. The modifications of the earlier orbit are all in the direction of the Berkeley orbit noted last week, consequently the differences between the respective ephemerides have been considerably reduced. According to Copenhagen Postcard No. 17 the new orbit is:—

$T = 1916$ March 11·2350 G.M.T. $P = 2008{\cdot}8$ days (5·50 y.
$\mu = 645{\cdot}163''$

Epoch 1916 Jan. 0·5 G.M.T.	Equinox 1916·0
$M_0 = 347^\circ\ 19'\ 24{\cdot}5''$	$\omega = 193^\circ\ 43'\ 17{\cdot}7''$
$\phi = 34^\circ\ 43'\ 4{\cdot}7''$	$\Omega = 327^\circ\ 30'\ 59{\cdot}6''$
$\log a = 0{\cdot}493559$	$i = 10^\circ\ 39'\ 53{\cdot}0''$

Ephemeris (Messrs. J. Braae and J. Fischer-Petersen), Greenwich midnight:—

	h. m. s.	° ′
April 28 ...	10 20 36 ...	− 9 41·9
30 ...	24 59 ...	10 10·7
May 2 ...	29 24 ...	10 38·7
4 ...	33 51 ...	11 5·9
6 ...	38 21 ...	11 32·3

Log Δ April 26, 9·7979, May 4, 9·8386

Observations made at the Hill Observatory, Sidmouth, on April 20 and 22, were represented by this ephemeris within the limits of accuracy attainable in the measures. On April 22, the sky being especially clear, the comet still showed a considerable diffused coma and a feeble condensation was glimpsed.

THE IRREGULAR VARIABLE STAR, T TAURI.—The annual report of the director of the Mount Wilson Solar Observatory for 1915 bears more resemblance to a review of the world's work in astronomical physics than the report of a single institution. The summary contains seventy-eight important items. No. 61 states that the irregular variable star, T. Tauri, is surrounded by an extensive atmosphere 4″ in diameter, which shows the bright lines characteristic of Wolf-Rayet stars. The spectrum of the star proper is about F5. The magnitude of this remarkable object ranges between 10·3 and 13·2. Notwithstanding the impressive output of work it appears there is room for regret—the 60-in. reflector remains the only instrument for work on stars and nebulæ, but it is offset by a crescendo of hope—the 10-in. portrait lens telescope is nearly ready, and the 100-in. reflector is expected to be in working order by the end of 1916.

A NEW VARIABLE STAR HAVING NEBULOUS ENVELOPE.—An addition to this at present very limited group of extremely interesting objects is announced by Mr. R. T. A. Innes in Circular No. 33 of the Union Observatory. The star is −37° 8450 in the Southern Crown, and normally its magnitude is 8·7, but on two occasions last year, October 29 and November 24, it was considerably fainter (12·4 and 11·5 respectively). The nebulous envelope was also found to vary. The 6·88 magnitude star, −37° 8449, possesses a similar appendage, and is so near to the above as to touch, thus affording an excellent basis for comparison. It is tantalising to think that these stars actually come above our horizon.

THE INDIAN SCIENCE CONGRESS.

THE proposal to assemble an Indian Science Congress was first put forward in 1913, and was due to the initiative of Prof. MacMahon and of Dr. Simonsen. The support of the Asiatic Society of Bengal gave to the new scheme a prestige which has helped it materially. The first congress was held at Calcutta in 1914, the second at Madras in 1915, and the third has recently been held at Lucknow. The future development of these congresses will be watched with interest by all who are engaged in scientific work.

India is struggling to devise an educational system that will satisfy her peculiar and complicated requirements; in her endeavours she has been the recipient of much criticism and advice; other countries have been held up to her as models, and she has been urged to adopt, for her numerous races and her tropical climate, methods that have been found suitable to homogeneous northern peoples.

Amid the clamour of politicians quarrelling over questions of primary education, the Government of India has had to consider the teaching of science at colleges and universities, and the prosecution of research in its scientific departments. In the last twenty years many well-qualified professors of science (physics, chemistry, zoology, medicine, mathematics) have been appointed, the Science Institute at Bangalore has been founded by the late Mr. J. N. Tata, the Research Institutes at Dehra Dun and Pusa have been erected and officered. In 1902, in order to prevent the duplication and overlapping of work, and in order to promote co-operation and touch, Lord Curzon created the Board of Scientific Advice, upon which each scientific department of State is represented.

The expansion of scientific teaching and work in India has created new wants, and the absence of scientific societies and of scientific libraries has now begun to be felt. Although the Board of Scientific Advice may prevent the Forest Department in its researches from overlapping the Agricultural Department, it does not bring the scientific departments into touch with the universities and colleges, and it does not bring together individuals who are working at the same branch of science.

If the Government of India had made no efforts to push on the teaching of science, it would have been blamed for supineness; now, however, that it is showing enterprise and determination, it is criticised for giving scientific education without providing a career or a livelihood for the youth whom it educates. It is pointed out that the educated youth of India is crowding into the legal profession, because it is the only learned profession that holds out a prospect of money-making. This statement is, however, no longer quite correct, as the medical profession is beginning to offer great chances to young men of ability. In every civilised country the public are willing to pay large fees to men who can save them from illness or can protect them in the law courts; and this fact will always render the legal and medical professions popular and lucrative.

The word "research" is now in common use, but what is meant by "research"? Some authorities, influenced by the commercial success of foreign medicines and of synthetic indigo, urge that research must be utilitarian; others are contending that science must be pursued for love of science only. Enough has been said to show the difficulties of the situation in India. In such a situation an annual congress of all interested in science cannot fail to be advantageous. Twenty years ago such a congress would not have been possible; twenty years hence it will have created for itself a powerful position.

In India workers in science are scattered to an extent which residents in England can scarcely realise. It is desirable that they should become personally acquainted. Without libraries and without intercourse individuals cannot keep abreast of the times. A congress meeting affords an opportunity for workers from every part of India to meet together and to discuss their difficulties, and is of particular value to the younger workers, in that they are able to present their results to audiences capable of offering sound criticism. Trained students from the Indian colleges are able at a congress to obtain information concerning chances of employment.

The recent congress at Lucknow was well attended by both Europeans and Indians, and the discussions showed great and general interest. Colonel Selby, the principal of the Medical College, had kindly placed some of his buildings at the disposal of the congress, which was opened on January 13 by Sir James Meston, the Lieutenant-Governor of the United Provinces. Sir Sidney Burrard was the president, and in his address he discussed the origin of the mountain ranges of India. The congress then separated, and meetings of its several sections were held—Agriculture, Zoology, Chemistry, Botany, Physics and Mathematics, Geology and Ethnology. It would serve no useful purpose to give complete lists of the papers read in the various sections. A report of the meeting, with abstracts of the papers read, has been published in the Journal of the Asiatic Society of Bengal for February, 1916.

From the papers presented to the Chemistry Section, it is clear that both among the European and Indian members of the teaching staffs at the various colleges and institutions, a keen desire to carry out chemical investigations exists, a desire which is shared also by the senior students of some of the colleges. Among the centres where such activity is pronounced are Calcutta, Madras, Dacca, and Bangalore. The growth of this desire to participate in chemical research has been most marked during the past few years, and the activity at present is such that materials for papers and discussion at subsequent meetings of the congress are assured.

In the Physics Section the attendance was large. Papers were read on atmospheric electricity; radio-activity of rocks; electrical discharge in gases; the oscillations of a violin string, and the history of mathematics, showing that the range of work was wide. The papers were of a high standard, and indicated that research in the physical sciences is healthy in India. Of the researches described in the papers read, four were made in Government scientific departments and eleven in university colleges. The meetings acted as a stimulus to those taking part in them.

Lucknow being a large city, the committee of the congress arranged for three lectures to which the public were admitted. The first was by Dr. Hankin, on the evolution of flying animals; the second by Dr. Bose, on invisible light; and the third by Prof. Neogi, on the manufacture of iron in ancient India.

With a record of three successful meetings, it seems clear that the Science Congress has established itself as a valuable aid to scientific progress in India. In the future it is perhaps possible that it may develop on broader lines and eventually grow into an Indian Association for the Advancement of Science, with greater scope for promoting scientific inquiry and co-operation. All who have been engaged in scientific work in India will realise the great benefits which might be conferred by such an association.

THE GLACIAL THEORY OF CORAL REEFS.[1]

SUESS'S demonstration that many of the relative changes of land and sea may be due to variations in the height of the sea, while the land remained stationary, and his suggestion that Darwin's theory of coral reefs was as consistent with a rise of the sea surface as with a subsidence of the sea floor, were followed by various attempts thus to explain the phenomena of coral islands. This explanation has now received its strongest support in a valuable memoir by Prof. R. A. Daly, who brings to the problem his usual thoroughness and ingenuity. His interest in the question was roused by the coral reefs of the Hawaiian Islands, which are so small that they are clearly young, and were probably all formed after the disappearance of the glaciers that once existed around the summit of Mauna Kea.

After some years of careful study, Prof. Daly concludes that the coral reefs of the world consist of a thin veneer of coral limestone resting on a great submarine bank; and he holds that the fundamental problem is the origin of these banks, and the recent establishment of the coral reefs upon them. His theory is that coral growth was checked or stopped by the chilling of the tropical seas during Glacial times; that as the temperature rose the coral polyps started active growth, while the sea surface was being gradually raised by the melting of the polar ice-sheets. Prof. Daly assumes that the ice-sheets of Europe, America, and the Antarctic all reached their maxima at the same time; and he calculates that the retention of this water on land would lower sea-level by from 27 to 33 fathoms, while the movement of sea water into the polar regions by the lateral attraction of the ice caps lowered the tropical seas another five fathoms. When the sea was thus lowered wave action planed down the great tropical banks and shelves which now support the coral reefs. One of the longest sections of the memoir discusses the depths of coral lagoons, and claims (p. 194) that "neither maximum nor general depths in atoll and barrier-reef lagoons of larger size should so nearly agree if subsidence has been the essential control in forming coral reefs."

The evenness of the lagoon floors may be due to the distribution of sediment by wave action; for the evidence collected by many authorities, such as Nansen and Stanley Gardiner, has shown that the influence of waves extends far deeper than the limit formerly accepted. The fact that no such great thickness of coral limestone as is assumed by Darwin's theory has ever been conclusively established cannot be lightly set aside; and Prof. Daly makes the novel suggestion that the formation of coral reefs may have been stopped by excessive heat as well as by cold. He remarks that when Grinnell Land had a January temperature 50° warmer than it has now, the growth of corals in the tropics was probably inhibited owing to the lowering of their vitality by excessive heat.

Prof. Daly has, therefore, adopted the bank theory of coral reefs, which, as he remarks, was advocated by Tyerman and Bennett in 1832, and in later times by Wharton and Agassiz. The part of Sir John Murray's theory which explained the depth of lagoons by solution is summarily dismissed. That Prof. Daly's explanation is correct for some coral islands may be at once admitted. Thus the evidence from the Maldives and Laccadives, which Prof. Daly clearly states, long ago led supporters of the Darwinian theory to regard those reefs as a coral crust upon a submerged ridge parallel to the Western Ghats. Sir William Wharton originally proposed that one of these islands should be selected for the boring test, but he withdrew this recommendation when it was pointed out to him at the British Association Committee on the subject that these islands would not be regarded as a satisfactory test; so he withdrew his proposal, and at the next meeting recommended Funafuti, which was afterwards selected for the famous boring. Its evidence, however, Prof. Daly rejects on the ground that the bore passed into coral talus, and that "the actual site of the borings was unwisely chosen" (p. 247); but taking all the circumstances into account, the site on Funafuti was probably the best available.

Glaciation has been summoned to relieve geologists from many difficulties, and in spite of the ingenuity of Prof. Daly's arguments, the Darwinian theory may still survive this appeal to Glacial influences. The fundamental assumption that all the Glacial ice-sheets reached their greatest size simultaneously seems opposed to the current trend of opinion. The Glacial period was obviously one of widespread earth movement; the subsidence of Scandinavia, the British Isles, and northern America during their glaciation would have tended to lower the sea-level; but these movements and the amount of water used in the formation of land ice might easily have been masked by uplifts under the tropical oceans.

One objection to the view that the coral reefs have grown upward to keep pace with a rise of sea-level has generally been regarded as fatal; for any such movements should have affected the whole of the tropical seas and should have been uniform throughout them. But vast lengths of coast show no sign of any such rise of sea-level. In the coral seas themselves some districts have raised reefs, while elsewhere the coasts present the features characteristic of subsidence. This fact was shown by Darwin, and has been confirmed by the detailed work of Alexander Agassiz. The grouping of coral reefs according to size and form is also evidence that the coral seas have been affected by differential movements of the sea floor. Dana showed that the coral islands are so grouped as to indicate rapid subsidence along certain lines, while adjacent areas remained stationary. Such facts of distribution appear irreconcilable with the Glacial control theory.

J. W. G.

[1] "The Glacial-Control Theory of Coral Reefs." By R. A. Daly. Proc. Amer. Acad. Arts Sci., Vol. li. No. 4, 1915, pp. 157–251.

ILLUSIONS OF THE UPPER AIR.[1]

A Review of Progress in Meteorological Theory in England since 1866.

The Study of Cyclones and Anticyclones.

IN 1866, a year after Admiral FitzRoy's death, the Royal Society undertook, by means of the new Meteorological Office, to establish seven other observatories in various parts of the country, equipped just like the Kew Observatory at Richmond, and to use the automatic records in explanation of the weather as set out in the daily maps. The explanation of the winds and the interest of the sailor were the justification of the public expenditure.

Meteorologists knew about cyclones from Piddington in 1848 and about anticyclones from Galton in 1863; from that time onwards until the end of the century the study of cyclones and anticyclones was the dominant idea of dynamical meteorology.

It was mainly conducted by observations at the earth's surface; and necessarily so. In 1852 Welsh, the superintendent of Kew Observatory, had made four sets of excellent observations of the upper air in

[1] From a discourse delivered at the Royal Institution on Friday, March 10, by Sir Napier Shaw, F.R.S.

balloons, and Glaisher had followed them up by a large number of ascents for the British Association, which reached their climax in the famous ascent with Coxwell in 1862. They added a good deal to our knowledge but very little to our ideas. They told us that the atmosphere showed continual decrease of temperature with height, and that surprised nobody; it was a natural incident in the gradual transition from the temperature of the surface of the earth to the absolute zero of space. "The nicely calculated less or more" was not of vital importance. Cyclones and anticyclones obviously belonged to the upper air, the regions where clouds are formed and dissipated, where rain and snow and hail are produced, but balloon ascents told us little about them beyond confirming the surmise that there are great ascending currents associated with certain forms of cloud.

The only real information to be got about the atmosphere in upper regions was that contained in observations of pressure at the surface, which is the cumulative result of the whole thickness of the atmosphere, and the amount of rain, hail, or snow which falls from above. There were also observations of the forms of cloud and their motion, and, if we please, of their position. The rest is necessarily speculation, so that out of these observations meteorologists were obliged to imagine for themselves what cyclones and anticyclones are, how far up they extend, how they are produced and maintained, what kind of air they are made of, and so on.

Observations of the Upper Air.

Speculation can do a great deal with the atmosphere. It goes beyond the reach of our balloons, and tells us of the substitution of hydrogen and the rarer gases for oxygen and nitrogen in the region of the meteor and the solar electron. But from the year 1896 onwards there has been a systematic collection of facts about the upper air by using kites to carry instruments up to heights of 3 kilometres, or occasionally more; ballons-sondes which carry instruments up to heights of 35 kilometres (20 miles or more); and pilot balloons which give the direction and velocity of the wind at various levels up to 10 kilometres, sometimes more.

Comparison of Fact with Speculation.

This investigation has given us a wealth of information about the upper air. The principal result is the division of the atmosphere into two layers: a lower layer about 10 kilometres thick, the troposphere, the region of convection; and an upper layer, the stratosphere, in which there is no convection. We can use the information to test some of the generally accepted ideas about cyclones and anticyclones by comparing the results of speculation with the new facts. Many of the pictures which we imagined now appear to have been illusions. Those of us, for example, who thought that because the air was warmed from the bottom, the upper part would be free from sudden changes of temperature such as we get at the surface were rapidly and rudely disappointed. Simplicity is not apparently the characteristic of the upper air.

The Convection Theory of Cyclones and Anticyclones.

Before giving you other examples, let me quote the description by which Galton introduced the name "anticyclone," because the mental picture of the structure of cyclones and anticyclones which has guided the thoughts of the majority of meteorologists has been formed by the gradual elaboration of the ideas contained in that description:—

"Most meteorologists are agreed that a circumscribed area of barometric depression is usually a locus of light ascending currents, and therefore of an indraught of surface winds which create a retrograde whirl (in our hemisphere)."

"Conversely, we ought to admit that a similar area of barometric elevation is usually a locus of dense descending currents, and therefore of a dispersion of a cold, dry atmosphere, plunging from the higher regions upon the surface of the earth, which, flowing away radially on all sides, becomes at length imbued with a lateral motion due to the above-mentioned cause, though acting in a different manner and in opposite directions" (Proc. Roy. Soc., vol. xii., 1862–1863, p. 385).

Out of that there gradually grew the conception, on the one hand, of the central area of a cyclone on the map as a centre of centripetal motion, a focus of attraction for the surrounding air, and of the general area of the cyclone as a region of ascending warm air producing rain or snow; round the central region the air moves inward with a counter-clockwise motion in spiral curves. On the other hand, the conception of the central area of an anticyclone is of a centre of centrifugal motion, a region of repulsion; the general area of an anticyclone is a region of descending cold air moving with a clockwise motion spirally outwards. The fundamental dynamical idea is that of air driven like gas along a pipe from high pressure to low pressure, retarded by the friction of the surface, and diverted from its direct object by the rotation of the earth.

For future reference, let us separate the three elements of this picture and keep them distinct. First, the *circulation,* counter-clockwise in a cyclone, clockwise in an anticyclone. Second, the *convergence* across the circulation from high to low. Third, the *convection,* or vertical motion, which appears as ascending air in the cyclone and descending air in the anticyclone.

According to the conception which developed on the lines of Galton's description, and found ready acceptance, the circulation is incidental to the convergence; the convergence is universal, the convection general.

It is another example of the *facilis descensus Averni.* The very simple piecing together of the three parts makes it almost obvious that the third element, the convection, is the effective cause of the whole dynamical process; it is natural to regard convection as the ascent of warm air in a relatively cold environment, causing low pressure on account of the relatively high temperature of the ascending air; and high pressure as the natural corollary of cold descending air. The convergence, or motion across the isobars, is the primary result of the distribution of pressure, and the circulation is merely the deviation from the straight path caused by the rotation of the earth. The theory is quite simple and quite self-contained, and it has this great advantage: that the cause which it assigns for the cyclone, namely, the convection of warmed air, has always been regarded as the cause of winds; it has been accepted as explaining land- and sea-breezes, the trade winds and the monsoons; and if it is also accepted as explaining the cyclone and anticyclone, which are the modern meteorological names for the diverse winds of the temperate latitudes, we can see in the idea a beautiful unity in meteorological theory. The origin of all the winds is thereby assigned directly to what we know must be their ultimate cause, namely, the warming of the lowest layers of the air by the warmed surface of sea or land. If we doubt its efficiency in one case, there seems no good reason for holding to it in the others.

It seems a pity that an illusion which apparently does such good service should be shattered; but it cannot face the facts of the upper air.

You will notice that the whole matter depends upon

the idea of the low pressure in the warm ascending air of the cyclone as the driving force, whatever be the area covered by the circulation. The observations of the upper air have made us familiar with certain facts about the height of the atmosphere that make such an idea too improbable. The convective atmosphere is only about 10 kilometres thick. The region in which convection can operate is therefore a thin skin represented by a centimetre in the case of a map on the millionth scale, on which 1000 miles is about 6 ft. in length. A cyclone is often regarded as a towering structure which may produce curious effects by tilting its axis, but that is clearly illusory; the idea that descending air over northern France is operating in conjunction with rising air over Iceland to produce a flow of air along the line joining them is an unproductive way of representing the facts.

The idea of the ordinary cyclones and anticyclones in our latitudes as foci of centripetal and centrifugal motion is an illusion. In all ordinary cases of cyclone the convergence of the paths of air towards the centre is itself an illusion, because the motion of the cyclone makes it miss its apparent aim, and we get in actual fact paradoxical cases of air which, always seeking a place of lower pressure, yet makes its way to a place of higher pressure, because the pressure has been raised over its path; and though it always seeks the centre, in reality it goes further away from it. If it wanted to reach it, it was a mistake to aim at it; if it wanted to get near, it should have aimed to get away. There certainly is convergence and convection, but it is local and not general over the cyclone. The idea which is conveyed by convergence in spiral paths to the centre of a moving cyclone is an illusion. It did not even require observation of the upper air to tell us that.[2]

Take the time required for the operating forces to produce any such wind velocities as we find in actual experience. In one hour an ordinary pressure-difference would produce a velocity of 1000 metres per second if it were free to act. The time required to generate a velocity of, say, 10 metres per second is infinitesimal compared with the time during which we see the forces in operation; these last for hours, or even days, while a minute would suffice for the production of all the velocities exhibited; the motion of the air which we register on anemometers is not accelerating motion but uniform motion, except for the effect of turbulence and local convection; so we must picture to ourselves the air of cyclones as being under the operation of balanced forces, not unbalanced forces. I wish to suggest that the idea of air being accelerated by the forces we see on the map is another illusion so far as the upper air is concerned.

The ostensible reason for supposing that the distribution of pressure created by convection is pushing air from high to low is due to the fact that the charted winds show the air at the surface crossing the isobars from high to low; the observations with kites and pilot balloons suggest that the effect is peculiar to the surface. If the driving force from high to low were the operative force which produces the wind of a cyclonic depression, we should expect to find its operation more strongly marked as we get higher up, because the friction of the surface would not interfere with it; but the fact is quite otherwise. The movement across isobars becomes less and less marked as we ascend. It is much less at Pendennis Castle than it is at Falmouth Observatory, a mile away. We cannot be sure that it exists at all at 1500 ft., because we cannot draw the isobars at that level with the necessary accuracy; the consensus of our observations goes to show that there is no real evidence of convergence at that level. There the centrifugal force of the air travelling over the moving earth, combined with the centrifugal force due to the curvature of the air's path, is sufficient to balance the force due to pressure, and there is no component of motion towards the centre.[3]

What happens nearer the surface is that the friction of the surface converts part of the energy of the motion of the wind into eddy motion and the air does not move fast enough on the right path to keep up the balance. Consequently, it drifts inwards as a pendulum does when its motion is retarded, but the lower air cannot hold back the air far above it; the effect of viscosity in that direction was shown by Helmholtz to be negligible. The effect of the eddy motion is very limited in height.

Observations in the Upper Air in Relation to the Convection Theory.

But the greatest blow to the illusion that I have portrayed comes directly from the observations of the upper air; the convection theory requires that the air of the cyclone should be warmer than that of the anticyclone, but, as a matter of fact, the new observations show that the opposite is the case.

In a paper published by the Royal Society, Mr. W. H. Dines[4] gave the mean values of the observations of temperature in the upper air of this country arranged according to the pressure at the ground. From his results the following table has been compiled:—

Table of Average Values of the Pressure, Temperature, and Density of Air in High and Low Pressure.

Height		High pressure			Low pressure		
		Pressure	Temp.	Density	Density	Temp.	Pressure
1000-ft.	k.	mb.	A	g/m³	g/m³	A	mb.
32·809	10	273	226	421	382	225	247
29·528	9	317	233	474	444	226	288
26·247	8	366	240	531	514	227	335
22·966	7	422	247	595	583	232	388
19·685	6	483	254	662	652	240	449
16·406	5	552	261	736	724	248	516
13·124	4	628	267	818	807	255	591
9·843	3	713	272	911	893	263	675
6·562	2	807	277	1012	992	269	767
3·281	1	913	279	1137	1100	275	870
0	0	1031	282	1270	1226	279	984

The figures show that a pressure-difference of 26mb. exists at the level of 10 kilometres where convection has ceased to exist. The difference is accentuated to the extent of 21mb. as the surface is reached by the existence of the high pressure transmitted from above, in spite of the relative coldness of the air at the lower pressure. The diagram included in Mr. Dines's paper showed that there is a remarkable change at the top of the troposphere. Above the level for which values are given in the table, *the high is colder than the low, reversing the state of things in the troposphere.*

We cannot resist the conclusion that the pressure-differences of cyclone and anticyclone are not local surface effects at all: we must seek their origin in the upper air where there is no convection. They are little affected by the lower stratum of 9 kilometres, which, roughly, marks the range of the effect of heating at the surface.

The idea of warm air in the lower layers causing the low pressures which are recorded on our barometers is therefore an illusion.

Thus it will be seen that the observations of the

[2] See "Life-history of Surface Air-currents." By W. N. Shaw and R. G. K. Lempfert. M.O. publication No. 174.

[3] See the four reports on wind structure to the Advisory Committee for Aeronautics by W. N. Shaw and J. S. Dines, also "Barometric Gradient and Wind Force," by Ernest Gold. M.O. Publication, No. 190.

[4] See M.O. Publication No. 210b. Geophysical Memoirs No. 2.

upper air have proved that all the vital parts of the facile description which was the accepted theory of cyclones and anticyclones are quite illusory. What it took for guidance in forming a picture of the structure was the accidental character of motion near the ground. We now feel that the motion of air in the lowest kilometre had better be disregarded, or, better still, be handed over to students of turbulent motion, while we as meteorologists consider the normal state of the atmosphere as motion under balanced forces. Instead of a natural flow from high pressure to low pressure, we have a natural flow without any change of pressure; the motion of a heavenly body round its sun is taken as the type for the air instead of the motion of a falling stone.

While we are considering illusions, let me add another example depending upon what was at one time, and possibly is still, a commonplace of physical teaching in regard to the relation of barometric changes to weather.

It is this: moist air is lighter, bulk for bulk, than dry air, and consequently pressure is low where the air is moist. That is why a low barometer is indicative of rain; the moist air causes the low pressure. This is not true to fact. Mr. Dines has recently examined the correlation between the humidity of the troposphere and the pressure at the surface. The coefficient is quite insignificant; there is no relation between moist air and low pressure on the map.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is announced in the issue of *Science* for March 31 that the wills of the late Edith and Walter Scull, niece and nephew of Mr. David Scull, for many years a manager of Haverford College, give 20,000*l.* to the college.

A MEETING convened by the Committee on the Neglect of Science will be held on Wednesday, May 3, at 3 p.m., in the rooms of the Linnean Society, Burlington House. Lord Rayleigh, O.M., will take the chair. A series of resolutions will be submitted to the meeting. Among those who have written in support of the objects of the meeting (many of whom will speak) are:—The Duke of Bedford, Lord Montagu of Beaulieu, the Lord Chief Justice, the Right Hon. Arthur Acland, Mr. Stanley Leathes (Civil Service Commissioner), the master of University College, Oxford, the rector of Exeter College, the master of Christ's, the headmaster of Westminster, the dean of Christ Church, Sir Harry Johnston, Sir Edward Schäfer, Sir William Crookes, Sir William Osler, Sir Ronald Ross, Sir Ray Lankester, Sir William Tilden, Sir Hugh Bell, Sir Robert Hadfield, Dr. Martin Forster, the headmaster of Sherborne, Mr. H. G. Wells, Sir Owen Seaman, and the Poet Laureate, as well as many other leaders in science, education, and industry. Those desiring invitations to the meeting should apply to the Committee on Neglect of Science, 28 Victoria Street, S.W.

WE learn from the issue of *Science* for March 24 that Mr. J. D. Rockefeller, junior, has been re-elected president, and Mr. J. G. Greene secretary, of the Rockefeller Foundation. The capital fund of the Foundation on January 1, 1915, was 20,009,600*l.* Grants amounting to 240,000*l.* not hitherto announced have recently been made by the Foundation. To the Rockefeller Institute for Medical Research 200,000*l.* is given for additional endowment needed in connection with the Department of Animal Pathology; and among other grants, the China Medical Board receives 25,000*l.* for the promotion of medical teaching in China. From the same source interesting particulars are forthcoming of the work of the General Education Board founded by Mr. J. D. Rockefeller to promote education within the United States. Since its inauguration and up to June 30 last the Board had made grants amounting to 3,372,400*l.* The value of the Board's resources is 6,791,800*l.*, and the gross income for 1915 was 446,000*l.* approximately. Among the grants made up to the date mentioned, we notice: for the endowment of universities and colleges, 2,334,500*l.*; for the current expenses of colleges and schools, 31,200*l.*; for salaries of professors of secondary education, 55,100*l.*; and for farmers' co-operative demonstration work, 157,200*l.*

THE approaching retirement of Dr. Lyttelton, the headmaster of Eton, has led to the suggestion that the governors of the college should appoint as his successor a representative of modern scientific learning instead of a classical divine. The usual objections have been raised to such a course, and the usual unenlightened opinions have been expressed as to the association of scientific education with German barbarity. It would be just as illogical to suggest that the war and its instruments of destruction were due to Christian doctrine as it is to assert that science is responsible for them. Science is concerned with the discovery of new phenomena, new forces, new relationships; and men may use them for good or ill—to ease pain and suffering, or to maim and destroy. It produces chloroform as well as chlorine, and enables a wireless call to be sent from a sinking ship as well as makes the explosive for the torpedo or mine which destroyed her. The popular conception of a man of science as a being without human compassion may do for the stage or a penny novelette, but it ought not to be too much to expect people who write to the leading newspapers to know better. We are glad to see, therefore, that the *Daily Mail*, in a leading article on April 22, gives strong support to the claims of science in public-school education. It points out that "clever talking has come to be regarded as almost or quite as important as sound and vigorous action. Precisely the same defect appeared in the later Roman Empire when its education degenerated into a mere study of rhetoric and declamation." Whatever defects we possess as a nation—and they have been unmercifully exposed in the present war—are due, not to science, but to its neglect. It is satisfactory to know that this is at last being realised by the public; and we hope it may be taken for a sign that, whether through a new type of headmasters or otherwise, the education of our future politicians, administrators, and manufacturers shall include general scientific knowledge and scientific method as essential constituents.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, April 4.—Dr. A. Smith Woodward, vice-president, in the chair.—G. A. **Boulenger**: The lizards allied to *Lacerta muralis*, with an account of *Lacerta agilis* and *L. Parva*. This paper is the third and last instalment of a revision of the wall-lizards, of which the first two parts were published in the Transactions in 1905 and 1913. The author has endeavoured to depart from the empirical method usually followed in the arrangement of species, by tracing back the various forms of this difficult group to a hypothetical ancestor of which *Lacerta agilis* appears to be the nearest living representative. The characters of lepidosis and coloration on which his views are based are discussed, and detailed descriptions are given of *L. agilis* and its ally, *L. parva*, the latter being

regarded as the connecting-link between the first and fourth of the six sections into which it is proposed to divide the genus Lacerta.—R. **Gurney**: Fresh-water Entomostraca collected by Mr. G. W. Smith in Ceylon in 1907. The collection contained examples of thirty-five species, and one species of Copepoda and two of Ostracoda were described as new, one of the latter belonging to the typically African genus Oncocypris.—Major R. **Meinertzhagen**: The Sitatungas (Limnotragus) of the Sesse Islands. The author found that the Bugalla Island antelopes of this genus seem to be of the same race as the mainland form, *Limnotragus spekei*, but that the Nkose Island form, which he proposed as a new subspecies, differed in the shortness of its hoofs and other characters.

Geological Society, April 5.—Dr. A. Harker, president, in the chair.—G. W. **Tyrrell**: The picrite-teschenite sill of Lugar (Ayrshire) and its differentiation. This sill is exposed in the gorges of the Bellow and Glenmuir Waters, just above the confluence of these streams to form the Lugar Water. It has a thickness estimated at 140 ft., and is intrusive into sandstones of the Millstone Grit. The contacts consist of contorted basaltic rock passing into teschenite. The upper teschenite becomes richer in analcite downwards, and ends abruptly at a sharp junction with fine-grained theralite. The lower teschenite becomes richer in olivine upwards, but passes rapidly into hornblende-peridotite. The central unit of the sill is a graded mass beginning with theralite at the top and passing gradually into picrite, and finally peridotite, by gradual enrichment in olivine and elimination of felspar, nepheline, and analcite. The average rock of the sill is much more basic than the rock now forming the contacts. Hence the main differentiation cannot have occurred *in situ*. The theory is advanced that the differentiation units were produced by the process of liquation, but that their arrangement within the sill took place under the influence of gravity. The sill is compared with other teschenite-picrite sills in Scotland, those of Ardrossan, Saltcoats, Blackburn, Barnton, and Inchcolm.

Linnean Society, April 6.—Prof. E. B. Poulton, president, in the chair.—Prof. G. C. **Bourne**: A description of five new species of Edwardsia, Quatr., from New Guinea, with an account of the order of succession of the micromesenteries and tentacles in the Edwardsidæ.—Prof. W. J. **Dakin**: A new species of Enteropneusta, from the Abrolhos Islands.

PARIS.

Academy of Sciences, April 10.—M. Camille Jordan in the chair.—G. **Bigourdan**: Some works of Peiresc. Particulars of some observations recorded in a manuscript dated November, 1610, to June, 1612, including work on the satellites of Jupiter, the moon and planets, and the nebula of Orion.—B. **Baillaud** and M. **Pourteau**: The calculation of right ascensions and declinations of stars of the photographic catalogue. The method worked out is illustrated by a numerical example for one star.—Ch. **Lallemand**: A project for the modification of the legal time. An adverse criticism of the daylight saving scheme proposed in France (see p. 183).—Pierre **Duhem**: The general problem of electrodynamics for a system of immovable conducting bodies.—C. **Guichard**: Plane networks which are at once the orthogonal projection af a network O and the orthogonal projection of a network G.—M. **Cerf**: The transformation of partial differential equations.—Paul **Gaubert**: A crystalline modification of sulphur showing spherulites arranged helicoidally.—G. **Lecointre**: The geology of Djebel Ouitita and the neighbourhood of Dar bel Hamri, western Morocco.—Raoul **Blanchard**: The existence of a glacial island at Grenoble. At the junction of the soft rocks of Grésivaudan and the hard rocks of Chartreuse and Vercors such a glacial formation might be expected, and one has been identified by the author near Grenoble.—Henri **Devaux**: The rapid action of saline solutions on living plants; the reversible displacement of a part of the basic substances contained in the plant. A living plant, Elodea, was washed with distilled water and no calcium could be detected in the washings. The plant was then treated with a solution of sodium or potassium chloride (1 in 1000). Calcium was proved in the liquid, which must have been extracted from the plant cells. This decalcifying action is accompanied by fixation by the plant of a portion of the alkaline metal.—G. **André**: The relations which exist between the presence of magnesium in leaves and the function of assimilation. It is known that crude chlorophyll extracted from leaves by alcohol, or light petroleum, always contains magnesium, the latter being left as phosphate on ignition. It has also been shown that magnesium is the only fixed element forming part of the chlorophyll molecule. Experiments were carried out on the leaves of horse chestnut, lilac, and Spanish chestnut, at different stages of growth (April to July), determinations of the phosphorus and magnesium both in the extracted and residual portions of the leaves being made.—Jules **Courtier**: Variations of the peripheral temperature of the body during suggestions of heat and cold. Under suggestion of cold there was an average increase in the peripheral temperature of 0·28°; under suggestion of heat, an average fall of 0·2°. These variations were in the opposite sense to those expected from the normal behaviour of the body under the action of heat and cold. The vasomotor reflexes do not appear to be affected by suggestion.—J. **Havet**: Relations between neurology and vascular apparatus in the Invertebrates.—F. **d'Herelle**: Contribution to the study of immunity. In the case of *Bacillus typhi murium* attempts to prepare an immunising serum have failed. It is now shown that the antiseptics used to kill the organisms in the preparation of the serum were too strong, not only killing the bacillus but profoundly modifying the toxins. It has been found that various volatile essences (mustard, cinnamon, thyme) can kill the bacillus without affecting the toxin, and a vaccine has been prepared on these lines capable of partially immunising mice against the infection.—Maurice **Beaussenat**: Wound of the heart by a shrapnel ball. Cardiotomy and extraction of the projectile from the right ventricle. Cure.

BOOKS RECEIVED.

Agricultural Research Institute, Pusa. Bulletin No. 56. Green-Manuring in India. By A. C. Dobbs. Pp. 55. (Calcutta: Superintendent Government Printing, India.)

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), 1914–15. Pp. iv+119. (Calcutta: Superintendent Government Printing, India.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1915. Pp. 128+plates x. (Hobart: Royal Society of Tasmania.) 6*s*.

Annual Report of the Board of Scientific Advice for India, for the Year 1914–15. Pp. 191. (Calcutta: Superintendent Government Printing, India.) 1*s*. 6*d*.

Report on the Calcareous Sponges collected by Mr. James Hornell at Okhamandal in Kattiawar in 1905–6 (with two plates). By Prof. A. Dendy. (London: Williams and Norgate.)

Report on the Non-Calcareous Sponges collected by Mr. James Hornell at Okhamandal in Kattiawar in 1905–6 (with four plates). By Prof. A. Dendy. (London: Williams and Norgate.) 4s. net.

Mysore Government Meteorological Department. Report on Rainfall Registration in Mysore for 1914. By N. Venkatesa Iyengar. Pp. xvii+49+plates iii. (Bangalore: The Government Press.)

The Principles of Plant Culture. By the late E. S. Goff. Revised by J. G. Moore and L. R. Jones. Eighth edition. Pp. xxiii+295. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 5s. 6d. net.

Department of the Interior. U.S. Geological Survey. Mineral Resources of the United States. Calendar Year, 1914. Part i., Nos. 3–13. Part ii., Nos. 8–30. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. lxv., Nos. 11, 12, 13. (Washington: Smithsonian Institution.)

Department of Commerce. Technologic Papers of the Bureau of Standards. Nos. 59, 62, 63, 68. Scientific Papers of the Bureau of Standards. Nos. 260, 261, 264, 265. (Washington: Government Printing Office.)

Department of the Interior. U.S. Geological Survey. 27 Bulletins. Water Supply Papers. 13 Papers. (Washington: Government Printing Office.)

Field and Laboratory Studies of Soils. By Prof. A. G. McCall. Pp. viii+77. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 2s. 6d. net.

Report of the Secretary of the Smithsonian Institution for the Year ending June 30. Pp. iii+110. (Washington: Government Printing Office.)

Report of the Commissioner of Education for the Year ended June 30, 1914. Vol. i. Pp. xxxviii+810. Vol. ii. Pp. xxv+565. (Washington: Government Printing Office.)

Smithsonian Institution. Bureau of American Ethnology. Bulletin 57. An Introduction to the Study of the Maya Hieroglyphs. By S. G. Morley. Pp. xvi+284. (Washington: Government Printing Office.)

Smithsonian Institution. U.S. National Museum. Bulletin 92. Bibliographic Index of American Ordovician and Silurian Fossils. By R. S. Bassler. Vol. i. Pp. viii+718. Vol. ii. Pp. iv+719–1521. (Washington: Government Printing Office.)

Leland Stanford Junior University Publications. University Series. The Pronoun of Address in English Literature of the Thirteenth Century. By A. G. Kennedy. Pp. 91. The Anoplura and Mallophaga of North American Mammals. By Prof. V. L. Kellogg and G. F. Ferris. Pp. 74+plates viii. (California: Stanford University.)

DIARY OF SOCIETIES.

THURSDAY, APRIL 27.

ROYAL SOCIETY OF ARTS, at 4.30.—Scientific Agriculture in India: J. MacKenna.

MATHEMATICAL SOCIETY, at 5.30.—The Green's Function for the Equation $\nabla n^2+k^2n=0$ (II): H. S. Carslaw.—On the Uniformity of Gaseous Density, according to the Kinetic Theory: S. Chapman.—The Nodal Points of a Plane Sextic: J. Hodgkinson.—Some Problems of Combinatory Analysis: P. A. Macmahon.—On the Deduction of Criteria for the Convergence of Fourier's Series from Fejér's Theorem concerning their Summability: S. Pollard.—On the Derivates of a Function: Mrs. G. C. Young.—Note on Functions of Upper and Lower Type: W. H. Young.

FRIDAY, APRIL 28.

GEOLOGICAL PHYSICS SOCIETY, at 5.—Presidential Address: Growths in Silica Gel: Prof. Benjamin Moore

MONDAY, MAY 1.

ARISTOTELIAN SOCIETY, at 8.—The Limitation of Pure Reason: Prof. G. Dawes Hicks.

SOCIETY OF CHEMICAL INDUSTRY, at 8.

MEDICAL SOCIETY, at 8 30.—Shakespeare and Medicine: Sir St. Clair Thomson.

TUESDAY, MAY 2.

ROYAL INSTITUTION, at 3.—Indian and Persian Painting: L. Binyon.

WEDNESDAY, MAY 3.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Salvarsan and Neo-Salvarsan, Excretion and Secretion of: W. H. Willcox and J. Webster.—Microscopical Methods: H. G. Greenish.

ENTOMOLOGIAL SOCIETY, at 8.

THURSDAY, MAY 4.

ROYAL INSTITUTION, at 3.—Flints and Flint Implements: Sir Ray Lankester.

IRON AND STEEL INSTITUTE, at 10.30.—Presidential Address. *Papers*: Notes on the Theory of the Corrosion of Steel: L. Aitchison.—Notes on the Relations between the Cutting Efficiencies of Tool Steels and their Brinell or Scleroscope Hardnesses: Prof. J. O. Arnold.—A New Thermo-Electric Method of Studying Allotropic Changes in Iron or other Metals: Dr. C. Benedicks.—Initial Temperature and Critical Cooling Velocities of a Chromium Steel: Dr. C. A. Edwards.—The Influence of Carbon and Manganese upon the Corrosion of Iron and Steel: Sir Robert Hadfield and Dr. J. N. Friend.—Early Experiments on the Recalescence of Iron and Steel: A. Mallock.—A Few Experiments on the Hardness Testing of Mild Steel: W. N. Thomas.—Surface Tension Effects in the Intercrystalline Cement in Metals and the Elastic Limit: F. C. Thompson.

LINNEAN SOCIETY, at 5.—The Origin of the Garden Red Currant: E. A. Bunyard.—The Dispersal of Organisms, as Illustrated by the Floras of Ceylon and New Zealand: Dr. J. C. Willis.—A Study of the Rectal Breathing Apparatus in the Larvæ of the Anisopterid Dragonflies: R. J. Tillyard.—Description of a New Species of Idotea (Isopoda) from the Sea of Marmora: W. E. Collinge.

FRIDAY, MAY 5.

ROYAL INSTITUTION, at 5.30.—Electrical Methods in Surgical Advance: Sir J. Mackenzie Davidson.

IRON AND STEEL INSTITUTE, at 10.—(See above.)

GEOLOGISTS' ASSOCIATION, at 7.30.—Field Notes on the Faunal Succession in the Lower Carboniferous Rocks of Westmorland and North Lancashire: Prof. E. J. Garwood.

SATURDAY, MAY 6.

ROYAL INSTITUTION, at 3.—X-Rays and Crystals: Prof. W. H. Bragg.

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