THURSDAY, MAY 1, 1919.

THE COMPLETE PHYSICAL CHEMIST.

A System of Physical Chemistry. By Prof. W. C. McC. Lewis. (Text-books of Physical Chemistry.) Second edition. In three volumes. Vol. i., "Kinetic Theory." Pp. xii + 494. Price 15*s.* net. Vol. ii., "Thermodynamics." Pp. vi + 403. Price 15*s.* net. Vol. iii., "Quantum Theory." Pp. viii + 209. Price 7*s.* 6*d.* net. (London: Longmans, Green, and Co., 1918–19.)

A REVIEW of the first edition of Prof. Lewis's book appeared in these columns in September, 1916, and the fact that a second edition has been called for so soon must be very gratifying to the author. Prof. Lewis has taken advantage of the opportunity thus presented him of introducing a few corrections and amendments, and has considerably increased the subject-matter. The principal changes include the insertion of a section on X-rays and crystal structure, large additions to the sections on colloids, catalysis, etc., a new chapter on osmotic pressure, and the expansion of the last chapter of the original vol. ii. into a separate vol. iii., dealing exclusively with the quantum theory. The excisions are remarkably few, and we have only noted one of any importance.

The author's method of treatment of his subject-matter naturally remains unaltered. The more classical portions are presented to the student in much the same manner as in several of the older text-books (and, it might be added, lecture courses). As regards more recent work the author is apparently well aware of his rather obvious lack of the critical faculty, and in the presentation does not emphasise any particular point of view as being his own. This he achieves by giving the results of each piece of work in, so far as possible, "the investigator's actual words." But, whatever we may think of the lack of criticism in the presentation of any particular summary, we must confess that, as a whole, the work included in the survey of each section is usually admirable in its selection. So broad is the field covered by the author that we can scarcely expect a critical and authoritative pronouncement on every separate item.

Considering more closely a few points in vol. i., we should have thought, since the work of Bohr and Moseley has now been embraced in the author's survey (in vol. iii.), that there would be some alterations in the first chapter. The author's sense of values appears at fault when he once again apportions more space to Nicholson's theory of the atom than to the whole subject of radio-activity. There are some parts of the subject, such as those dealing with the nuclear charge and isotopism, the omission of which seems particularly regrettable. As it stands, this small section has scarcely been brought up to the knowledge of the year 1916, far less of 1918, and this is true of other references to the subject, such as that on p. 449, which also seems in urgent need of revision. In the summary of the Braggs' work presented in the second chapter we were struck by the consistent use of the sequence (y, x, z) instead of the customary (x, y, z) in the naming of intercepts, and by the referring to the sodium chloride space lattice as face-centred, while what is meant is face-centred relative to one kind of atom. In chap iii. we once again encounter "the more convenient logarithmic form $\Sigma v \log C = K$" instead of the usual log K. On p. 197 the last column in the first table is still uncorrected. Prof. Lewis apparently now regards methyl-orange as "essentially a basic indicator," and in consequence inserts as a correction the word *basic* on p. 256, with the result that we are informed that, since methyl-orange is neutral-coloured in a 10^{-4} H$^{\cdot}$ solution, "its (basic) dissociation constant lies in the neighbourhood of 10^{-4}." This should evidently be 10^{-10}. On p. 440 the author introduces as a new term "the *displacement* effect." In view of the use that has already been made of the defining word in Wien's *displacement law*, the term is not too happily chosen, and "*replacement* effect" is perhaps as suitable a descriptive term.

Turning to vol. ii., we find that a great portion consists in the presentation, with the aid of thermodynamics, of matter which has already been partly discussed in vol. i. Whether this separation is altogether desirable is an arguable point. To select an example at random, we confess we are unable to see the virtue in giving in vol. i. a table of the temperature variation of a mass action constant, while the theory of the variation is given in vol. ii. Again, in the new chap. viii., "the *mechanism* of osmotic pressure" might have seemed more in place in the first volume, which deals with the kinetic point of view. As it is, of course, it fits in quite well. In the addition at the end of chap. i., in speaking of the vapour pressure in a column, the author remarks: "the pressure at the top being *entirely* due to the kinetic bombardment by the molecules." But surely it could be argued that the pressure at the foot is also *entirely* due to the kinetic bombardment by the molecules, even if it is greater than the pressure at the top by the weight of the column per unit area. We note that the author has now adopted "S" in place of "ϕ" as the symbol for entropy. In his brief reference to the entropy equation of a perfect gas there is no adequate discussion of C_v, and the evasion of the lower limits of the integral is not too adroit. A symbol, by the way, is omitted in the first equation on p. 46. The footnote on p. 100 to the effect that "thermodynamic reversibility has, of course, nothing to do with reversibility in the chemical or mass action sense" seems open to question. On p. 140 the author is evidently unable or unwilling to decide against Planck, though Planck has undoubtedly slipped. As regards the footnote on p. 142, there is a laboratory method of measuring e.m.f. which does *not* involve the use of a potentiometer.

The third volume presents in an easily accessible form the most important theoretical and practical work on the quantum hypothesis, embracing much that is not included in Jeans's report. We have noted one awkward slip, a "howler" on p. 27 in the proof that the central force is equal to mv^2/ρ. The angle between tangent and secant is made equal to the angle *at the centre*, and then by an abuse of infinitesimal geometry the correct answer is obtained. In chap. v., on the structure of the atom, we are surprised to find Moseley's work dismissed in less than a page, the same space nevertheless being allocated to Allen's empirical relation, while Barkla is not mentioned. There is a misprint in the second formula on p. 115. We sincerely deprecate the habit of bestowing double-barrelled names on equations save when there is clear evidence of independent discovery. From the text-book it would appear that the "Marcelin-Rice" equation (p. 139) was discovered by Marcelin, and the method of deduction improved by Rice. If this is the case the second name should be dropped from the equation. We should have liked to see the appendices (of which i. and ii. are by J. Rice) incorporated in the text.

We have confined our attention almost entirely to the additions and alterations made by the author in his new edition. If we have emphasised the defects rather than the excellences of his work, we must plead that we are seeking to help him in the presentation of the only complete system of physical chemistry by an English-speaking author. We have no hesitation in saying that we regard these volumes as absolutely indispensable books of reference to every advanced worker in physical chemistry and chemical physics, though it is unfortunate from the point of view of a standard text-book that the author's treatment of the newer portions of his subject will compel him to make frequent changes in subsequent editions. A. M. W.

ACIDOSIS.

The Principles of Acidosis and Clinical Methods for its Study. By A. Watson Sellards. Pp. vi+117. (Cambridge, Mass.: Harvard University Press, 1917.) Price 4*s.* net.

ACIDOSIS may be defined as a condition in which there is a diminution in the normal slight alkalinity of the blood or tissues of a living organism; and a real or supposed state of acidosis has come in recent times to play a leading part in the explanation of many abnormal symptoms, including in particular a number of those which have been produced in the course of the war. The whole subject is thus one of considerable present scientific interest, and for this reason Dr. Sellards's book on the principles of acidosis is specially welcome.

The fact that in the living body the faintly alkaline reaction of the blood and tissues is regulated in a remarkable manner has been known for long. The non-volatile acid or alkali produced within, or introduced into, the body varies considerably, according to the composition of the food; and in man acid predominates, mainly on account of the fact that the alkali contained in the food is not sufficient to neutralise the sulphuric and phosphoric acids produced in the oxidation of proteins. The excess of inorganic acid is partly got rid of by the secretion of an acid urine, and partly neutralised by the formation of ammonia; while organic acids introduced into or formed within the body are for the most part oxidised along with other organic materials, the resulting carbonic acid being got rid of in respiration. It is only in recent years, however, that it has been shown that the concentration of free carbonic acid in the blood is regulated by the breathing with extreme delicacy, and that the breathing is itself normally regulated by the very minute changes in hydrogen-ion concentration produced by variations in the concentration of free carbonic acid in the blood, or by variations in its hydrogen-ion concentration from other causes.

The lungs thus constitute a safety valve which acts more freely or less freely according as the hydrogen-ion concentration of the blood increases or diminishes. We can correlate the variation in respiratory activity, first, with the variations in concentration of CO_2 in the air of the lung alveoli, and consequently of the free carbonic acid in the arterial blood; secondly, with the corresponding variations in hydrogen-ion concentration of the arterial blood. The result of this correlation has been to show that the regulation of hydrogen-ion concentration in the blood of man is so delicate that existing methods of measurement are far too coarse to reveal the changes in reaction to which the breathing reacts, unless where there are very great variations in the breathing. Thus with the existing methods of measurement the hydrogen-ion concentration of the blood appears to be constant; and where apparent distinct variations have been found they have nearly always been due to faulty methods of measurement. Minute variations in hydrogen-ion concentration are constantly occurring, as shown by variations in the breathing, but, as a rule, they are too small to be directly measurable by existing methods. There is also evidence that extremely small variations in hydrogen-ion concentration are of very great physiological importance.

Unfortunately, these considerations have not as yet been fully realised by medical men, or by more than a few physiologists, and the result is a veritable pandemonium of doctrine and practice in connection with real or supposed acidosis and its treatment. Dr. Sellards's book is not free from the prevailing confusion, as he seriously misinterprets the connection between breathing and the hydrogen-ion concentration of the blood. His book is, nevertheless, valuable and very well written. He rightly lays stress on the fact that, except in the extremest cases, accurate measurements show no variations in the hydrogen-ion concentration of the blood. But he proceeds to conclude that no variations exist even in what

he regards as quite well-marked "acidosis." He defines acidosis, not as a state in which the hydrogen-ion concentration of the blood and tissues is abnormally increased, but as one in which the reserve of fixed alkali in the body is depleted. This depletion is shown by the fact that, whereas in a normal individual it only requires a small dose of sodium bicarbonate to make the urine alkaline, it requires a very large dose in the case of a patient suffering from acidosis.

The evidence which Dr. Sellards adduces to illustrate the soundness of this test for acidosis is very interesting and, in the main, new. Much of this evidence is from observations which he made in the Philippines in treating kidney inflammation in cholera. Acidosis may be due to abnormal flooding of the body with organic acids, as in diabetic coma, or to failure on the part of the kidneys to excrete acid, as in kidney inflammation. In either case the test proposed by Dr. Sellards indicates the condition. But the whole subject becomes much clearer if it is recognised that in serious acidosis there is an actual increase in the hydrogen-ion concentration of the blood, and that of this increase the increased breathing is by far the most direct sign. It appears to be the untrustworthiness of direct means of measuring small differences in hydrogen-ion concentration that has led some writers in this country to deny that dangerous acidosis exists at all in such conditions as diabetic coma or kidney disease, although both the greatly increased breathing and the favourable effect on the symptoms of large doses of sodium bicarbonate indicate the existence of what is, physiologically speaking, an extreme state of acidosis.

The confusion is rendered still greater by failure to distinguish primary acidosis due to flooding of the body with acid from the secondary acidosis which is an adaptive physiological response to lack of oxygen, and leads to increased ventilation of the lungs and, consequently, increased supply of oxygen to the blood. This form of acidosis is met with typically at high altitudes and in various conditions, such as poisoning by irritant gases, where the free supply of oxygen to the body is interfered with. Here the acidosis is brought about by diminution in the amount of fixed alkali or "alkaline reserve" in the blood, with the result that the breathing is increased. There is no directly measurable increase in hydrogen-ion concentration of the blood, nor, in view of what has already been said, could this be expected; but the increased breathing is, nevertheless, good evidence of the existence of an increase. The diminution in alkaline reserve in the blood is easily detected, either by titration or by a diminution in the capacity of the blood for combining with CO_2; and the latter method, particularly in the form given to it by Van Slyke, has been extensively used during the last year or two. The acidosis detected in this indirect way has, however, frequently been interpreted as in itself a symptom to be combated by alkalis, when it is in reality an advantageous compensatory reaction. Fortunately, the body can usually dispose of even large quantities of alkaline medicaments administered through this misunderstanding. Dr. Sellards's test for acidosis would exclude a compensatory acidosis, but would also lead to a compensatory acidosis being missed, and perhaps, as a consequence, to the cause of the compensatory acidosis being overlooked.

To interpret the significance of increased breathing, diminished alkaline reserve in the blood, or any of the other symptoms which usually accompany acidosis, it is necessary to take the whole of any existing abnormal physiological conditions into account, just as in interpreting the significance of any one of the usual physical signs of disease it is necessary to consider the whole of the symptoms and their course. The confusion which exists at present on the subject of acidosis is largely due to neglect of this principle. Perhaps this confusion is rendered most evident by the quite recent discovery by Yandell Henderson that when an animal is dying of "alkalosis," produced by withdrawing carbonic acid from the body by excessive artificial respiration, the alkaline reserve in the blood is greatly diminished in a physiological effort of the body to preserve the normal reaction; and, conversely, that when an animal is suffering from extreme acidosis owing to a great excess of CO_2 in the inspired air, the alkaline reserve of the blood is greatly increased in a corresponding compensatory effort. A diminution in alkaline reserve of the blood is thus not by itself a certain index of acidosis, or of whether or not an acidosis, if it exists, is harmful.

J. S. HALDANE.

TROPISMS.

Forced Movements, Tropisms, and Animal Conduct. By Prof. Jacques Loeb. Pp. 209. (Philadelphia and London: J. B. Lippincott Co., 1918.) Price 10*s.* 6*d.* net.

A PROLIFIC investigator does a great service to his brethren when, without waiting to write an elaborate treatise, he collects the gist of some considerable portion of his work into a book; and if the book be a small one, so much the better. This Prof. Loeb has now done, and we are immensely obliged to him. What is more, his volume is but the first of a series, by American writers, all dealing with the wide field of experimental biology, a field in which we at home have done comparatively little, but in which American biologists have greatly distinguished themselves. Among the promised monographs are one by Prof. Morgan on "Chromosomes and Heredity"; another, by Dr. Jennings, on "Pure Line Inheritance"; a third, by Dr. T. B. Robertson, on "The Chemical Basis of Growth"; and a fourth, by Prof. Osterhout, on "Permeability and Conductivity of Living Tissues." In every case (and there are many more besides these) the author has won, and more than won, his right to be heard, and in every case also we feel the need of an authoritative guide to the subject in question.

Prof. Loeb is an out-and-out "mechanist," as we all know. He is impatient (as he tells us in the first words of his preface) with "the attempts of vitalists to show the inadequacy of physical laws for the explanation of life." He insists on the "quantitative methods of the physicist," and will have nothing to say to the romantic, or anthropomorphic, tales of "scientific popularism." His book begins with an account of the symmetry of the organism, as the starting-point for his theories of conduct; that is to say, he finds in the existence of bodily symmetry, whether radial or bilateral, a simplification of all further analysis. The symmetry is a dynamical as well as a morphological one; there is a symmetry which corresponds with the impulses from without, as to the reactions from within; muscular system and nervous system have their own corresponding symmetries, and the whole problem of action and reaction is simplified thereby. But it does not follow that all animals are symmetrical—at least, in this simple fashion. The spiral Euglena, for instance, is a harder case; and the experimentalist may convert the symmetrical into an unsymmetrical animal, as when he destroys one hemisphere of a dog's brain, or makes a beetle blind of one eye. The "reflex actions" of the physiologist are the reactions of parts, or isolated segments; a similar or analogous reaction of the whole is likewise assumed to be, or may be interpreted as, a phenomenon of a purely physico-chemical nature. And these reactions of the whole organism are what Prof. Loeb calls "tropisms."

Through such reactions, or tropisms, Prof. Loeb leads us, in connection with the various stimuli of light, heat, electricity, chemical action, gravity, contact, and so forth, and at last comes face to face with the more recondite themes of instinct and memory. Let us consider a single experiment out of the great number which this small book relates. Many animals, very humble ones included, tend to move towards the light, while some, on the other hand, retire into the darkness or the shade; some love the light, and some hate and avoid it, as we are apt, in our anthropomorphic fashion, to say. Suppose, now, that we illuminate the two eyes of a fly by separate beams of light, of equal intensity and similarly directed. The fly will not choose between the two lights, says Prof. Loeb, as a belated traveller might choose between the lights of two village inns; it will do something much simpler, and apparently more mechanical. It will travel straight along a line perpendicular to that which joins the two lights; it will follow the resultant of the two stimuli. Not only so, but if we alter the direction of the beams, or cause them to differ in intensity, so that in either case one eye receives more illumination, more "phototropic stimulus," than the other, then the creature will move along a perfectly definite line, which can still be simply calculated as the resultant of the two forces involved. The experiment is an ingenious and an elegant one, and, without for a moment doubting the results which Prof. Loeb and his pupils have repeatedly obtained, we can honestly say that we should dearly like to see it performed.

We dare not attempt to discuss the great philosophic questions that are involved in the whole course of these experiments. We have a notion that "anthropomorphism" is not got rid of quite so easily, however much we change our phraseology, as Prof. Loeb would have us believe, and that, great as are the lessons of mechanics, they do not tell the whole story, after all. Be that as it may, the element of precision, the quantitative element, the strict, experimental method, is conspicuous in Prof. Loeb's work, and our knowledge is manifestly increased thereby. I think it was Liebig who said, in one of his letters to Faraday, that (in those days) a man might be an eminent geologist in England who knew nothing of physics, nothing of chemistry, nothing even of mineralogy. Change the wording, and the biologist may (or once upon a time might) have begun to feel uneasy. It is something to be taught or reminded by Prof. Loeb, and by the whole brotherhood of experimental biologists, that the naturalist cannot live alone, but works in a field inextricably connected, for better for worse, with the whole range of the physical sciences.

Prof. Loeb has a boundless wealth of ideas. In this book and in his other books and papers we seem to see them tumbling one over another. He has enough and to spare for all his pupils and fellow-workers, so that all who come to him may eat and be filled. Moreover, his manifold experiments all have the hall-mark of simplicity, and this is surely one of the greatest things that can be said of any experimenter. There is no parade of elaborate apparatus, nor does it ever seem to be required. *Simplex sigillum veri!*

The book concludes with a bibliographical list of nearly six hundred titles—a catalogue of books and papers on experimental biology, in the sense in which Prof. Loeb himself deals with it. In the first hundred and fifty titles (and I have gone no further in my analysis) sixty-three are German, forty-three American, thirty-eight French, and four more are Dutch or Italian. I shrink from doing the addition and subtraction which would reveal our British share.

D'ARCY W. THOMPSON.

OUR BOOKSHELF.

The Strawberry in North America. History, Origin, Botany, and Breeding. By Prof. S. W. Fletcher. Pp. xiv+234. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 8*s.* net.

WITH marked success Prof. Fletcher has gathered into a comprehensive survey much information of great interest in the history and development of the strawberry. Though the book is primarily written for American readers, it appeals to the English gardener and student of horticulture, as English varieties and methods of cultivation had a strong influence on the improvement of the fruit in North America. Garden cultivation began

about 1700, but growing for market purposes was not seriously taken up for another century, after which the need for improved varieties soon arose. A new era was ushered in in 1834 by the introduction of the Hovey strawberry, which was the first named variety to be produced by definite plant breeding in North America. From this time the development of commercial cultivation was rapid, and it was accentuated by the competition due to increased facilities for transporting the fragile berries over longer distances. The tenderness of the fruit necessitated a search for the ideal package for marketing, and many descriptions of punnets, boxes, tubs, and trays have been exploited.

The survey includes an outline of observations and experiments on the crossing of species and the raising of new varieties. The illustrated account of present-day methods of breeding and selection gives a useful summary of the subject, and the sketches of abnormal freak berries are of interest to the morphologist. The biographical notices in the last chapter form a fitting conclusion to the book by directing attention to the men to whose careful and patient work is due the great improvement in the strawberry in North America.

The Journal of the Institute of Metals. No. 2. 1918. Vol. xx. Edited by G. Shaw Scott, secretary. Pp. xi+382. (London: Published by the Institute of Metals, 1918.) Price 21*s.* net.

THE twentieth volume of this valuable publication contains a variety of papers of scientific and technical interest. The May lecture, by Sir Charles Parsons, describes the experiments on the artificial production of diamond made by the lecturer during the last thirty years, and discusses the bearing of the results obtained on the problem of the origin of natural diamonds. A group of papers deals with the grain growth of metals, Dr. Zay Jeffries giving a review of the whole subject, and making much use of experiments with tungsten filaments. The observations are by no means easy to interpret, and some of the conclusions appear to contradict one another; but the author has made a most important contribution to a subject of great interest, and it may be possible shortly to bring the facts into harmony. Mr. D. Hanson, in a short note, describes experiments on the same problem, discussing the relation between the rapidity of grain growth at a given temperature and the amount of deformation to which the material has been previously subjected.

A third paper, by Mr. R. J. Anderson, describes the effect of short exposures to various temperatures on cold-rolled aluminium sheet, and although it is the hardness in this case, and not the grain size, which is measured, the phenomena involved are essentially similar to those discussed in the preceding papers. Prof. Edwards gives an account of the method of determining hardness by measuring the resistance to penetration under impact, and there are several contributions on the subject of commercial copper alloys. An interesting communication by Mr. W. E. Alkins records the effect of progressive cold work on the tensile properties of copper wire, an abrupt change being observed at a certain stage in the reduction of cross-section by drawing. The allotropic change assumed by the author requires more evidence before it can be accepted as an explanation, but the facts are remarkable, and must be taken into account in future work. The volume includes the usual abstracts of publications referring to the non-ferrous metals. C. H. D.

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 Doppler Effect in the Molecular Scattering of Radiation.

IN connection with the recent work of Prof. Strutt and of Lord Rayleigh on the molecular scattering of light, Sir Joseph Larmor has put forward the interesting suggestion (*Phil. Mag.*, January, 1919, p. 162) that the additive property of the energy elements scattered by the individual molecules is secured by the irregular alterations in the wave-length of the scattered radiation produced (in accordance with Doppler's principle) by the thermal movements of the molecules. There is one interesting feature of the Doppler effect in the scattered radiation to which Sir Joseph Larmor does not specifically direct attention in his paper, and which it seems important to emphasise, namely, that the magnitude of the Doppler effect would depend on the *angle* between the primary and the scattered radiation, and would, in fact, practically vanish in directions nearly the same as that of the primary waves. This follows from the fact that the movement of an individual molecule would alter the effective frequency of the radiation *received* by it, and this has to be taken into account in calculating the effective frequency of the *emitted* radiation as received by the observer. In directions nearly the same as that of the primary radiation there would be practically a complete compensation, and the Doppler effect would vanish.

The importance of the considerations set out above becomes evident when we attempt to explain refractivity on the basis of molecular scattering. This appears possible only if the energy effects due to the individual molecules are *not* additive in directions nearly the same as that of the primary wave, and the vanishing of the Doppler effect in the scattered radiation would seem to be a necessary condition for mutual interference of the radiations from individual molecules to be possible. C. V. RAMAN.

210 Bowbazar Street, Calcutta, March 19.

THE point developed in a new direction by Prof. Raman had been noted by Lord Rayleigh, and was mentioned very cursorily in the last sentence of my paper in the *Phil. Mag.* to which his letter refers. The main purpose of that paper was to express the view that, so far as I understand, independent scattering of light by the molecules of a homogeneous

medium, so dense that there are very many molecules per cubic wave-length—for example, in the atmosphere—must arise from the thermal motions of the molecules rather than from irregularity of their spacing. In directions, however, that are nearly coincident with the transmitted ray there can be no sensible dispersal of phase from either cause; disturbances, therefore, completely conspire, and the light scattered by the molecules in such directions is, in Lord Rayleigh's phrase, specially favoured. Prof. Raman points out that if the phases in directions near that of the ray did not in fact thus agree, the molecules of the material medium could take no concordant part in the transmission of the energy of the main beam, and regular propagation would be impossible. It is involved in this remark that each molecule will exert its full effect on the index of refraction, however irregular the distribution may be, provided it is not so dense that the molecules will obstruct each other; and, moreover, the thermal motions will not disturb this effect. The specially favoured directions, for disturbances passed on by the molecules, must be almost coincident with the ray—must, in fact, belong to the ray after the manner of diffraction, when it is regarded as a physical filament of light rather than as a geometrical line.

The light that may be scattered in a crystal must, on any view, be due either to motes embedded in it or to the thermal motions of its molecules around their regularly spaced mean positions. A beautiful recent experiment by Prof. Strutt, now reported in the Proceedings of the Royal Society, exhibits a spiral beam scattered sideways when plane-polarised light passes through a column of quartz; thus, incidentally, it puts in direct visual evidence the slow rotation of the plane of polarisation of the vibrations which arises from the spiral structure of the crystal.

JOSEPH LARMOR.

Cambridge, April 24.

INDIAN ASTRONOMICAL INSTRUMENTS.[1]

INDIAN astronomy, handed down to us in a series of text-books, the *Siddhântas*, of which the earliest dates from about A.D. 400, is an offspring of Greek astronomy. *Via* Babylon and the Greek kingdom of Bactria (the Kabul valley and the Punjab), Greek science was introduced into India in the course of the two or three centuries following the invasion of Alexander the Great. While, during the Middle Ages, many astronomers in western Asia and North Africa did good work by re-determining astronomical constants and improving planetary tables by new observations, no attempts whatever in this direction were made in India. It is therefore very curious to find that an extremely belated effort to revive the study of astronomy, and at last to try to advance this science by independent work, was made early in the eighteenth century in the north of India.

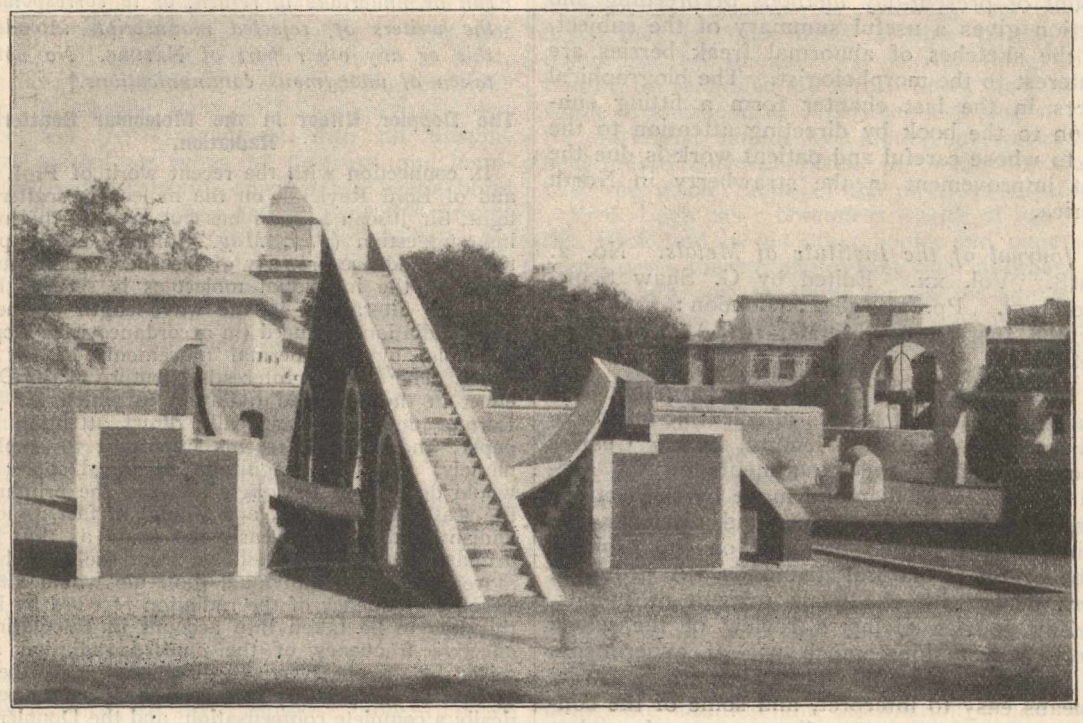

FIG. 1.—General view, Jaipur Observatory. From "The Astronomical Observatories of Jai Singh."

Rajah Jai Singh of Jaipur (born 1686, died 1743) was interested in astronomy from his youth. He wrote or caused to be written an astronomical work named after the Emperor Muhammad Shah, of which there are now extant an imperfect copy in Sanskrit (at Jaipur), and a complete MS. in Persian in the British Museum. It contains a star catalogue, which, however, is nothing but the catalogue of Ulugh Beg, with 4° 8′ added to the longitudes to allow for precession. A translation of the introduction was published by Hunter in the "Asiatic Researches," vol. v. (1799); it is

[1] "The Astronomical Observatories of Jai Singh." By G. R. Kaye. (Archæological Survey of India, New Imperial Series, vol. xl.) Pp. viii+151+26 plates+1 map. (Calcutta, 1918.) Price 23s.

reproduced by Mr. Kaye in the valuable book now under notice. In this introduction Hipparchus is referred to as an ignorant clown, and Ptolemy as a bat who can never arrive at the sun of truth; the demonstrations of Euclid are said to be an imperfect sketch, and "the European tables" to be often in error. Jai Singh therefore decided to erect new instruments of colossal size, similar to those made by Ulugh Beg at Samarkand in the fifteenth century. Among the latter we know from other sources that there was a quadrant of 180-ft. radius, while a 60-ft. sextant is said to have been erected at Baghdad in A.D. 992. Before the application of diagonal scales or verniers to graduated arcs there was only one way of making single minutes and fractions of them distinguishable—by enlarging the instruments as much as possible. Jai Singh first constructed a number of astrolabes of iron or brass, from 6 in. to 7 ft. in diameter, many of which are still preserved at Jaipur. In four plates Mr. Kaye gives sixteen photographic illustrations of these astrolabes, but most of them are too indistinct to show details.

Jai Singh's chief work, however, was the building of masonry instruments, ranging from a few feet to 90 ft. in height, at Delhi, Jaipur, Ujjain, Benares, and Mathura. They have often been described in a more or less sketchy manner in books on India; but Mr. Kaye gives an exhaustive account of them, beautifully illustrated by a number of plates.[2] They are really nothing but gigantic sun-dials. Thus the *Samrāt Yantra*, or "supreme instrument," consists of a gnomon in the form of a rectangular triangle with the hypotenuse parallel to the earth's axis, and an equatorial arc on either side. The two largest examples are at Delhi (height 68 ft., radius of arcs 49½ ft.) and at Jaipur (90 ft. and 50 ft.) (Fig. 1). The *Jai Prakas* is a hemispherical bowl, on the concave surface of which are marked the equator, meridian, and other circles, on which the shadows of wires might fall. The *Ram Yantra* (Fig. 2) is a cylindrical wall with a vertical pillar in the middle. Neither these nor any of the other instruments show any originality of design. The best known of these five collections of masonry instruments is probably the Delhi Observatory, called the Jantar Mantar, built about 1724,

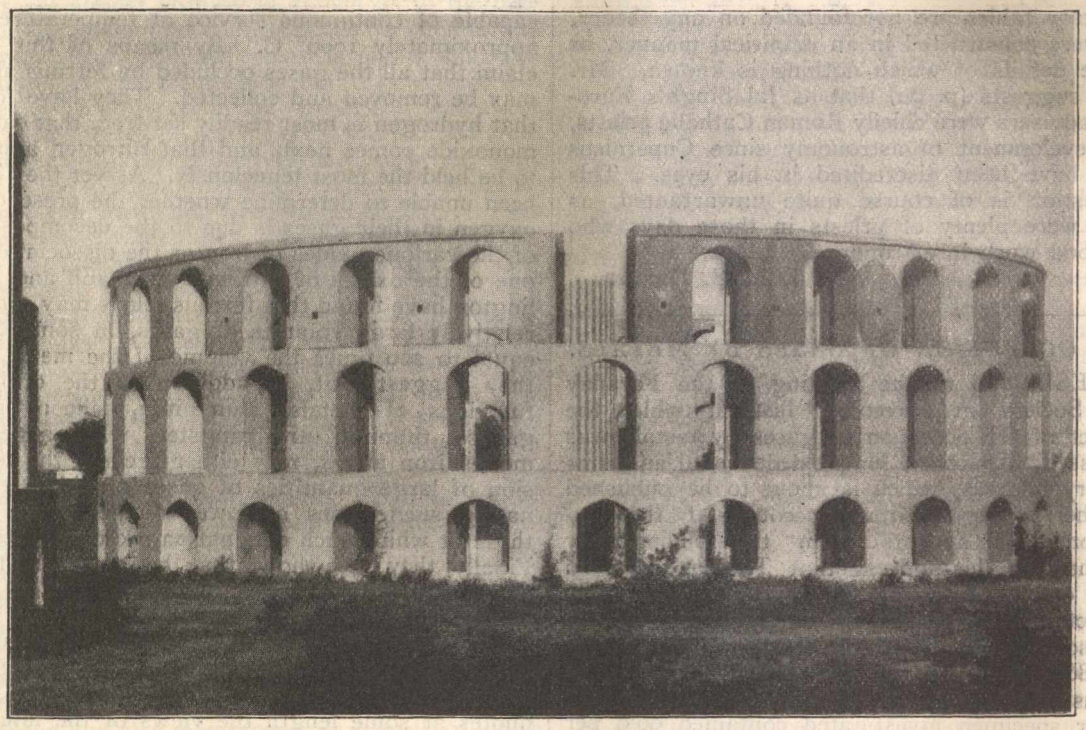

FIG. 2.—The Ram Yantra, Delhi, North Building. From "The Astronomical Observatories of Jai Singh."

3½ miles south of the Ridge, so that it will be a notable feature in the new capital. It contains six instruments. The graduations on the gnomon of the *Samrāt Yantra* are scratched into the lime-plaster surface, but those of the quadrants are well marked with a soft, black stone neatly inlaid into the face of the arcs. This seems, however, to be the result only of a restoration carried out in 1910–12. At Jaipur the instruments are well preserved, being within the precincts of the palace. At Benares the instruments were erected in 1737 on the roof of a building; they are therefore of moderate size. A much-needed restoration took place in 1912. At Ujjain the four instruments are in a state of ruin, and those at Mathura have quite disappeared.

There is no record of any attempts having been

[2] There are a number of tiny models of them in the South Kensington Museum.

made to do systematic work with these instruments, nor would it have been of the slightest use to employ them for anything but lecture-demonstrations. In 1728 or 1729 Jai Singh sent Figueredo, a Portuguese Jesuit, to Europe to procure astronomical tables, and he brought back "tables published under the name 'Lir,'" *i.e.* the tables of La Hire. Mr. Kaye also thinks that Jai Singh possessed the "Historia Cœlestis" of Flamsteed, and says (p. 69) that "he must have been acquainted with the teaching of Kepler, Galileo, and Newton, for he possessed the works of La Hire, Flamsteed, and others." But neither of these works could give the slightest clue to the teaching of European astronomers. The "Historia Cœlestis" contains Flamsteed's observations and the resulting star-catalogue (as well as reprints of previous catalogues), and La Hire's planetary tables are not founded on any theory, but were constructed in an empirical manner, as to the details of which nothing is known. Mr. Kaye suggests (p. 90) that as Jai Singh's European advisers were chiefly Roman Catholic priests, the development of astronomy since Copernicus must have been discredited in his eyes. This suggestion is of course quite unwarranted, as there were plenty of priests in those days who did good work in astronomy.

J. L. E. DREYER.

THE OCCLUSION OF GASES BY METALS.

PRESIDING at the meeting of the Faraday Society in November last, at which the subject of the occlusion of gases by metals was discussed, Sir Robert Hadfield delivered an introductory address, which is about to be published by the society with an account of the discussion. It appears from the bibliography attached to this address that Thomas Graham was one of the first to investigate this subject. His results were published in the Philosophical Transactions of the Royal Society in 1867, the title of the paper being "The Occlusion of Gases by Meteoric Iron." The particular specimen investigated contained 90·9 per cent. of iron, 8·45 per cent. of nickel, and a small quantity of cobalt. It was free from any stony admixture, and was remarkably pure and malleable. A strip cut from this with a clean chisel was first well washed with a hot solution of potash, then with distilled water, and afterwards dried. It was then placed in a porcelain tube which was evacuated and afterwards heated to redness in a combustion furnace.

Gas was observed to come off freely, and was collected in successive portions. The first portion evolved consisted principally of hydrogen. Succeeding portions also contained hydrogen as the chief constituent, with smaller quantities of carbonic oxide and nitrogen. This particular specimen of iron yielded 2·8 times its own volume of gas. Graham also investigated the gas taken up by iron from a carbonaceous fire, and in the case of some clean horseshoe nails which he heated in a similar way he found that the metal yielded 2·66 times its own volume of gas, containing about 50 per cent. of carbonic oxide, 35 per cent. of hydrogen, 7·7 per cent. of carbon dioxide, and 7 per cent. of nitrogen. He concluded that as hydrogen was recognised in the spectrum analysis of the lights of the fixed stars, the Lenarto meteoric iron which he had investigated came from an atmosphere in which hydrogen was the chief constituent, and that it held imprisoned within it the hydrogen of the stars.

The latest investigations on the subject of "Occluded Gases in Ferrous Alloys" are those by Allemann and Darlington, whose results are published in the proceedings of the Franklin Institute of Philadelphia in February, March, and April of 1918. These investigators describe a gas-tight vacuum furnace which they have constructed capable of continuous service at temperatures of approximately 1900° C. By means of this they claim that all the gases occluded by ferrous alloys may be removed and collected. They have found that hydrogen is most readily set free, that carbon monoxide comes next, and that nitrogen appears to be held the most tenaciously. As yet they have been unable to determine whether the presence of oxygen in their gases is due to the decomposition of the various oxides of iron or the dissociation of one of the oxides of carbon. Allemann and Darlington have found that ferrous alloys may occlude relatively large volumes of gases, in some cases equal to 200 times the volume of the metal, and they suggest that, in addition to the ordinary functions of metals, aluminium, silicon, manganese, titanium, and tungsten, when added to molten iron alloys, may either prevent the occlusion of large quantities of gases or aid in eliminating such gases at lower temperatures than those at which such elimination ordinarily occurs. Finally, they have shown that the removal of these gases markedly changes the microstructure and increases the density of the alloys.

Sir Robert Hadfield then proceeds to consider the bearing of scientific work of the foregoing kind on the problem of obtaining sound steel, and quotes at some length the views of the late Dr. Héroult as set forth in his paper on "The Presence and Influences of Gases in Steel." Héroult pointed out that the gases obtained from blowholes in unsound steel ingots always contain hydrogen and nitrogen, often with only traces of carbon monoxide, but it is well known that sound steel, when heated *in vacuo*, also gives off these gases. It has also been shown that the quantities of gases so liberated are about the same, whether the steel be made by the crucible, the Bessemer, the open hearth, or the electric furnace. In consequence of this he concluded that hydrogen and nitrogen are not the cause of the production of blowholes, but that the latter are the result of the liberation of carbon monoxide, except in the case of blowholes near the surface, which are due to the poor condition of the moulds. Héroult's view of the production of blowholes was as follows:—

The carbon monoxide does not pre-exist in the

steel. It is produced only when the latter cools down and has partly solidified. Steel that will produce blowholes contains in the molten condition dissolved carbon and oxygen, and for each temperature and composition there is a particular equilibrium at which no chemical reaction takes place. The heat is then what is called "dead-melted." If, on one hand, the temperature is raised, the reducing action of the carbon is intensified, and carbon monoxide will be evolved; if, on the other, the temperature is lowered, nothing happens until the steel has partially solidified. This causes an increased concentration of carbon and oxygen in the still liquid portion, as a result of which carbon monoxide is evolved. This gas is unable to escape, and by its pressure produces the blowholes. On cooling, it is gradually absorbed by the now solid metal.

As yet almost nothing is known as to the condition in which these gases exist in metals and alloys. Prof. McBain pointed out in his contribution to the discussion that the occlusion of gases by metals comprises processes which are special instances of the general group of different phenomena known collectively as "sorption," and that in the vast majority of cases the intermingling phenomena have not been disentangled or even experimentally identified. It is necessary to take into consideration true adsorption (surface condensation), true absorption (true solution in a solid), and chemical reactions that may ensue.

Sir Robert Hadfield finally considers briefly the methods which have been found effective in producing sound steel. As he points out, great difficulties were experienced in the early days of making steel castings in producing sound metal. The very useful element silicon was scarcely obtainable except in combinations which caused as much trouble as the unsoundness itself. High-percentage ferro-silicons with low carbon and silico-speigels were unknown. Manganese, though useful, was only a partial cure, and aluminium as a commercial metal had not yet arrived.

It appears that it was three French metallurgists who introduced and perfected the successful production of ferro-alloys containing high percentages of silicon and also manganese, as a result of which the manufacture of sound steel by commercial processes on a large scale was rendered possible. These men were MM. Euverte, Pourcel, and Gautier, of the Terre Noire Works. Credit should also be given to Hall in America and Héroult in France, who were the pioneers of the production of aluminium on a commercial scale. This element is now one of the most valuable available for the prevention of blowholes in steel. As an instance of the successful production of sound steel castings at the present day Sir Robert Hadfield gives some details of the casting of hydraulic cylinders for cotton baling presses. These cylinders have no mechanical work done upon them, but are used in the cast state. They may run up to a length of 30 ft. The ram measures from 7 in. to 9 in. in diameter. The walls of the cylinders seldom exceed 2¼ in. in thickness, and have to stand the hydraulic test pressure of 4 tons per sq. in. The steel is cast at a temperature of about 1540° C., and is poured into sand moulds which are liable to give off gases. Its contraction is slightly more than 0·25 in. per ft., so that the mould is not less than 7 in. longer than the cylinder itself when cooled down. Below 1500° C. the steel quickly loses its fluidity, and not many degrees lower it is quite pasty. The fact that, in spite of the difficulty of meeting these conditions, satisfactory cylinders can be made indicates that the art of steel casting has reached a high stage of technical perfection. H. C. H. C.

PROF. J. J. T. SCHLŒSING.

AGRICULTURAL investigators in all countries will learn with regret of the death of Prof. Jean Jacques Théophile Schlœsing at Paris on February 8. Although Prof. Schlœsing had attained the advanced age of ninety-four, his vigour and mental alertness were unusually good, and he had had the satisfaction of seeing his son continuing in his own branch of science, doing work of great importance, and making a reputation scarcely less distinguished than his own.

Schlœsing was born at Marseilles on July 9, 1824; he entered the Polytechnic in 1841, and was appointed director of the Ecole des Tabacs in 1846. There he began an important series of analytical investigations the purpose of which was to improve the method of detecting and estimating the common constituents of soils and plants, such as potassium, ammonium, nitric, phosphoric, and hydrochloric acids, and the common organic acids, such as acetic, tartaric, citric, oxalic, malic, and others. The current methods of dealing with natural products were sometimes exceedingly laborious, and lacked even the merit of accuracy; the determinations of ammonia in rain-water made with all possible care by Lawes and Gilbert in 1853 had involved the distillation of 2 cwt. of rain and evaporation of the distillate with sulphuric acid; even then the results came out something like 100 per cent. too high. It is impossible, therefore, to over-estimate the value of careful analytical investigations such as those made by Schlœsing.

His next important series of investigations was on the soil. By a lengthy washing process he obtained a preparation of the finest clay particles which remained indefinitely suspended in pure water, but could be precipitated by traces of a calcium or magnesium salt. This was commonly regarded as being in some sense the essential clay, and agricultural chemists marvelled at the minute amount present even in heavy soils. The conception served a useful purpose, but it has now been replaced by a broader one: the soil is now considered to be made up of particles varying from 1 mm. downwards to molecular dimensions, the different groups merging one into another without perceptible breaks. The clay group is assigned for convenience an upper limit of 0·002 mm., but this is regarded as purely conventional.

Another important investigation had to do with the movements of lime in the soil. The conditions of solubility were determined, and deductions were drawn which threw important light on the practices of liming and marling, and on the presence of lime in natural waters.

Further, Schlœsing studied the effect on plant growth of the carbon dioxide and ammonia present in the atmosphere, in the soil, and in natural waters. He set up the well-known hypothesis that the proportion of carbon dioxide in the atmosphere is related to the extent of dissociation of the bicarbonates in the sea. The sea was thus regarded as a reservoir which equalises the stock of carbon dioxide in the atmosphere, taking up any excess that might be formed at any time, and supplying any deficit from the average amount should such ever arise.

Schlœsing's best-known work, however, was on nitrification. For a long time it had been known that nitrates are gradually formed when plant or animal residues, farmyard manure, etc., are incorporated in the soil. The process was of much technical importance in the seventeenth and eighteenth centuries as the source of nitrate for gunpowder. During the Thirty Years' War and other great Continental wars the various Governments had been seriously concerned in these so-called nitre beds, and had done a good deal to stimulate their development. The conditions of the change were tolerably well ascertained, but nothing was known as to its mechanism.

It has several times happened in the history of civilisation that agriculture has benefited by knowledge gained during war. The mass of information accumulated during the eighteenth-century wars, and apparently rendered useless in the nineteenth century by the promise of peace and the discovery of nitrates in Chile, was found to be of fundamental importance in agriculture. It was found that the nutrition of plants so far as nitrogen was concerned depended on the nitre-bed processes; organic nitrogen compounds, useless as plant nutrients, when added to the soil became converted into highly valuable nitrates; the more rapidly this change could be brought about, the better for the plant. So long as the mechanism of the change was unknown, the old knowledge was simply empirical and incapable of full utilisation. Many investigations were therefore made, but for years the problem remained unsolved. The balance of opinion was in favour of a purely physical process, but there was also a strongly supported chemical hypothesis.

Schlœsing and Muntz had been working at the formation of nitrates in sewage during the process of nitrification, and they noticed an inert period of twenty days before the commencement of nitrification. With characteristic shrewdness they observed that this delay could scarcely arise if the process were purely physical or chemical; some biological factor seemed to be indicated. In order to test this possibility they added a little chloroform to the sewage; nitrification at once stopped. They then removed the chloroform, and "seeded" with a little fresh sewage; after an interval nitrification began again. This afforded strong evidence that the process was due to living organisms, and in course of time the proof was made more rigid by Winogradsky's isolation of the specific organism.

This research is one of the foundations of modern soil bacteriology, and for this alone Schlœsing would be remembered. But his other work has also played an important part in the development of the subject, and he may justly be regarded as a worthy successor to the great Boussingault, whom he followed at the Conservatoire des Arts et Métiers in 1887. He carried on the high standard set by his predecessor, and leaves a name that will long be held in high honour and esteem.

E. J. RUSSELL.

NOTES.

THE Prime Minister's list of New Year honours, the publication of which has been delayed by circumstances arising out of the armistice, was issued on Monday, and includes the following names of workers in scientific fields:—*Baronet:* Dr. Norman Moore, president of the Royal College of Physicians. *Knights:* Mr. R. T. Blomfield, past president of the Royal Institute of British Architects; Lt.-Col. J. M. Cotterill, C.M.G., consulting and late acting surgeon, Edinburgh Royal Infirmary, and lecturer in clinical surgery, Edinburgh School of Medicine; Prof. Israel Gollancz, secretary of the British Academy since its foundation; Prof. R. A. Gregory, chairman of the Organising Committee, British Scientific Products Exhibition; Mr. H. J. Hall, organiser under the Ministry of Munitions of the section dealing with the production of fertilisers; Dr. Edward Malins; Mr. J. H. Oakley, president of the Surveyors' Institution; Prof. W. Ridgeway, professor of archæology, University of Cambridge; Dr. C. S. Tomes, F.R.S.; and Dr. T. J. Verrall, chairman of the Central Medical War Committee.

THE joint meeting of the Faraday Society and the Röntgen Society, held at the Royal Society on Tuesday for the discussion of "The Examination of Materials by X-rays," afforded remarkable testimony to the wide interest taken in the opportunity which such a meeting provides of bringing together theoretical knowledge and practical experience of a scientific subject. The meeting-room of the Royal Society was crowded, and one twice the size could easily have been filled. The discussion, of which we shall give an account in a later issue, began in the afternoon, and was continued in the evening after adjournment for dinner, to which a large company was invited by the president of the Faraday Society, Sir Robert Hadfield. It was an unusual privilege for the Royal Society to grant the use of its meeting-room for a discussion organised by other societies, but there could not be a more appropriate place for such a meeting, and the society itself might with advantage arrange for similar meetings at which all scientific workers in wide fields are actively interested. The success of the Faraday Society discussions is due chiefly to the rare combination of pure and applied science and unbounded energy manifest in Sir Robert Hadfield, and to the untiring work of the secretary of the society, Mr. F. S. Spiers. It was particularly pleasing to note the number of the younger generation of scientific workers present at the meeting. No more encouraging sign could be

given of the vitality of British science, and we trust that the Faraday Society will be strengthened greatly by increase of membership to continue its valuable work of co-ordinating scientific activities. The address of the society is 82 Victoria Street, Westminster, S.W.1.

UNFAVOURABLE weather has as yet delayed the trans-Atlantic flight, and the aeroplanes, although perfectly ready for the start eastwards, have still to wait for weather conditions which, at all events, will give them some chance of success in their attempt at crossing. There are few days in the course of the year when the whole passage from Newfoundland to Europe is quiet and favourable to the safe passage of aeroplanes. May and June are probably as favourable as any time throughout the year for settled and favourable weather conditions, but this does not mean that such favourable conditions occur in these months every year. At this season there is commonly at times a large amount of easterly wind. On an average there are fewer gales in the North Atlantic, and if storms develop they are of less intensity than at other seasons. In mid-Atlantic fog is most prevalent during the summer season, but an aeroplane would be well above this, although it would prevent passing vessels being seen. In Newfoundland fogs are more prevalent at St. John's than on the north-east coast, the latter part being peculiarly free from fog throughout the year. On our own coasts fogs are most prevalent in the winter. For the last week there can be no doubt about the stormy character of the weather, and the conditions throughout the route have become less favourable than in the preceding week; from this it must not be understood that the conditions have been sufficiently settled for the flight since the aeroplanes have been ready. The heavy snowstorm and gale over England on Sunday last sufficiently illustrate the suddenness of our weather changes. The Air Ministry in its bulletin issued on the evening of April 28 said: "Strong northerly winds, with squalls and much low cloud to the westward of Ireland, continue to render the conditions unsuitable for the flight."

AN excellent summary of the work of our Air Services has been issued as a Parliamentary paper under the title "Synopsis of British Air Effort during the War," and was reprinted in the *Times* of April 24. The enormous growth of the Air Force is illustrated by figures, and an idea of the extent of its activities may be gained from the fact that on the Western front, between July, 1916, and Armistice Day, more than 7000 enemy machines were brought down, nearly 7000 tons of bombs dropped, 10½ million rounds fired at ground targets, and 900,000 flying hours completed. The aid of the man of science has been called for in many ways, apart from the fundamental investigations of aerodynamics and the principles of flight. Examples of this may be found in such important work as the design of oxygen apparatus and electrically heated clothing for use at great altitudes. Photography, again, has played a marvellous part, as may be gathered from the statement that in a single month more than 23,000 negatives were made and 650,000 prints issued. The photographic branch has now 250 officers and 3000 other ranks, and it is estimated that no fewer than five million prints of aerial photographs have been issued by the Air Services in the field. Another great sphere of scientific activity has opened out in connection with the application of wireless telegraphy to aircraft; and this branch of the Service, which was in its infancy in 1914, now possesses 520 officers and 6200 other ranks, numbers which testify to the great progress made. Never before in history has science been so widely and effectively employed as during the recent struggle, and the Air Services alone afford an example which should establish for ever the great value of organised scientific research.

A SNOWSTORM of unusual severity for so late in the season occurred generally over the British Isles on Sunday, April 27, and in the south-east of England the storm was particularly severe. On the morning of Sunday a subsidiary disturbance was developing over the northern portion of the kingdom, and it afterwards moved southwards and eastwards over England, the parent disturbance being centred over Denmark. By the evening the subsidiary had assumed more serious proportions than the primary to the north-eastward, and was now centred over London and the south-east of England. Snow or hail fell in all districts of the United Kingdom. A region of high barometer extended from Iceland to the Azores which caused strong northerly winds in the rear of the disturbance, and gale force was reached in all districts, whilst at Holyhead the wind force attained the velocity of seventy miles per hour during Sunday night. In London snow commenced at about 1 p.m. after somewhat heavy rain, and it thoroughly covered the ground by 3 p.m. The depth of snow by the early morning of April 28 in the north of London was 12 in. to 15 in., and the total precipitation in the twenty-four hours was 1·6 in. at Camden Square and 1·7 in. at Hampstead. The snowfall occasioned much dislocation of the telegraph and telephone services, and the rapid melting of the snow caused floods in many parts. Temperature on April 27 was abnormally low for so late in the season, the thermometer in London during the afternoon standing at about freezing point. Agriculturists and fruit-growers have suffered somewhat badly.

A NEW expedition to the Antarctic is announced to sail in June, 1920. It will be known as the British Imperial Antarctic Expedition, and will be under the leadership of Mr. J. L. Cope, who accompanied the Ross Sea party of the recent Imperial Antarctic Expedition, 1914–17, as surgeon and naturalist. Mr. Cope's plans are ambitious and cover a wide area. Primarily, he aims at ascertaining the position and extent of minerals of economic value in Antarctica, and, by observations on the distribution and migration of whales, to foster the British whaling industry. It is understood that his plans include a base at New Harbour, in Victoria Land, and a wintering party in the middle of the Ross Barrier, mainly with a view to meteorological and magnetical observations. The ship itself, which is to be the *Terra Nova*, a vessel of proved capacity for Antarctic work, will spend the second winter at or around Cape Ann, in Enderby Land. Since that is a part of Antarctica which is practically unknown, a wintering party cannot fail to achieve results of great value. It is proposed to make use of an aeroplane for survey work and facilitating the choice of a route for sledge journeys. It is hoped that by this means Mr. Cope will be able to map the missing coast-line between Enderby Land and Wilkes Land to the east, and between Enderby Land and Coats Land to the west. Later it is proposed to follow the coast of Antarctica from Graham Land to Edward Land. The expedition is expected to last for six years, during which time communication with civilisation will be kept up by wireless telegraphy. While the plans, so far as announced, seem sound and likely to result in valuable discoveries, Mr. Cope might perhaps be well advised to curtail the duration of the expedition by at least two years. In any case, it is practically certain that his ship will require to dock for overhaul and minor repairs after two or three years among the ice.

THE Indian Public Works Department has lost a zealous and capable administrator by the death of Mr. George Thomas Barlow, Chief Engineer and Secretary in the Irrigation Branch of the United Provinces Government. Mr. Barlow's connection with irrigation work in northern India had been long and honourable, dating back in unbroken sequence to the year 1887, when he went out to India after a course of technical training at Coopers Hill, followed by a year of practical engineering work in Scotland. From that time until his death he was continuously engaged on irrigation schemes, at first at various posts on the Ganges, and afterwards, from 1901, in Bundelkund, a trans-Jumna tract of the United Provinces, where he was executive engineer on a considerable number of undertakings for ameliorating drought-stricken areas. Under Mr. Barlow's direction many surveys of different localities were made, numerous reservoirs constructed, and large masonry dams and canals brought into existence. He was promoted Superintending Engineer in 1911, and received the C.I.E. for his services in 1915. The following year he was appointed Secretary to the Government in the Irrigation Branch, and so recently as last October he was placed on deputation with Mr. Meares to undertake a systematic hydro-technical survey of the whole country. He was engaged in these researches up to the time of his death. Mr. Barlow was the author of several text-books dealing with irrigation work.

THE death of Mr. A. McHenry, which occurred somewhat suddenly on April 19, removes one of the oldest and most assiduous workers from the field of Irish geology. For more than forty years Mr. McHenry was on the staff of the Geological Survey, and the first mapping of some of the difficult areas in the north-west of Ireland fell to his share. He was always responsive to new discoveries, and was as enthusiastic in the revision of Silurian rocks by their graptolitic zones as in tracing thrust-planes and possible inversions of succession. His warm-hearted and unselfish character has left an enduring memory from days when controversies were not always conducted with such marked generosity and consideration. The Memoirs of the Geological Survey of Ireland contain ample evidence of his original observations. In addition, Mr. McHenry was the first to point out how the succession of intrusive igneous rocks in the Mourne Mountains corresponds with the volcanic episodes farther north, and he has left behind him unpublished records which may prove to be of considerable service in the elucidation of the problem of the Dingle series.

THE task imposed on industries by the war was the production in quantity of accurately standardised products. To ensure the successful development of peace-time trade, the high standard of accuracy and quality thus set must be maintained, and this is possible only by the institution in each factory of a system of inspection similar to that in operation during the war. Particulars have reached us of a new organisation, called the Technical Inspection Association, which has been formed recently for this purpose. There are doubtless many private firms which desire to set up a system of inspection in order to ensure interchangeability and uniform quality of these products. Such firms will be interested in the new association. The objects of the association are to keep members of the inspection staff of the Ministry of Munitions in close touch with each other, and to develop generally the progress and standardisation of methods of inspection in engineering, chemical, and allied industries with the view of conserving and co-ordinating the experience gained during the war for national use. The work will thus be of considerable scientific interest as well as industrial value. The temporary address of the association is Hotel Metropole, Northumberland Avenue, London, S.W.1.

WE regret to record the death of Mr. Wilfred James Lineham at Brighton on April 22. Mr. Lineham, who was sixty years of age, was well known as a teacher of engineering and as an author of engineering text-books. He was connected with the Goldsmiths' College for thirty years, and was formerly on the staff of the Armstrong College, Newcastle-on-Tyne. He took an active part in the founding of the Association of Teachers in Technical Institutes, and for many years was a member of the engineering faculty of London University. Mr. Lineham was a member of the Institutions of Civil Engineers, Mechanical Engineers, and Electrical Engineers. During the war a great deal of munition work was carried on at the Goldsmiths' College, and there is little doubt that Mr. Lineham's death was accelerated by the heavy work entailed thereby. It is of interest to note that he was an artist, and had exhibited at the Royal Academy. He had many friends, both amongst practical engineers and teachers, and his loss will be deeply regretted.

THE seventy-second annual meeting of the Palæontographical Society was held at the rooms of the Geological Society, Burlington House, on April 25, Dr. Henry Woodward, president, in the chair. The council's report announced the completion of the seventy-first volume of monographs, with instalments of Wealden and Purbeck fishes, Pliocene Mollusca, Cambrian Trilobites, and Palæozoic Asterozoa. Mr. Henry Dewey, Dr. F. L. Kitchin, Mr. W. P. D. Stebbing, and Mr. Henry Woods were elected new members of council. Dr. Henry Woodward, Mr. Robert S. Herries, and Dr. A. Smith Woodward were re-elected president, treasurer, and secretary respectively.

THE death is announced of Dr. Fernand Priem, honorary professor of geology in the Lyceum of Henri IV., and correspondant of the National Museum of Natural History, Paris. Dr. Priem was born on November 10, 1857, at Bergues, near Dunkerque, and studied palæontology under the late Prof. Albert Gaudry. He made many notable contributions to our knowledge of fossil fishes, among which may be specially mentioned his memoir on the fossil fishes of the Paris basin, published separately by the *Annales de Paléontologie* in 1908, and his description of new Cretaceous fishes from Persia included in the report of the Mission de Morgan in the same year

THE annual British Academy lecture on a master mind (Henriette Hertz Trust) will this year have as its subject "Leonardo da Vinci," and be delivered by Mr. C. J. Holmes, director of the National Gallery, in the rooms of the Royal Society on Friday, May 2, at five o'clock, this being the anniversary of the death of Leonardo da Vinci. Sir Frederic Kenyon, president of the British Academy, will be in the chair.

DR. WINIFRED CULLIS and Miss Mona Wilson have accepted membership of the Industrial Fatigue Research Board, recently appointed by the Department of Scientific and Industrial Research and the Medical Research Committee jointly to study questions of industrial fatigue.

SIR HUGH CHARLES CLIFFORD, Governor of the Gold Coast, has been appointed Governor and Commander-in-Chief of the Colony and Protectorate of Nigeria, in succession to Sir Frederick Lugard, who will retire from the Colonial Service in July.

SIR J. G. FRAZER contributes to the March issue of *Man* a note by Rai Bahadur K. Ranga Achariyar on the customs of the Todas in connection with the milk of their sacred dairies. In relation to the Hebrew prohibition against seething a kid in its mother's milk, Sir J. G. Frazer has discussed milk taboos in his recent work, "Folk-lore in the Old Testament" (vol. iii., pp. 111 ff.). But all the taboos on the dairy and the milk are meant only for the well-being of the Todas primarily and of the buffaloes secondarily. There is not the slightest trace among them of the belief that the restrictions are in the interests of the buffaloes or for their benefit, or that there is a magical sympathy between the cows and their milk. The parallel between the Toda and Hebrew customs is thus not clearly established, but the facts now fully reported for the first time are of considerable interest.

IN *Science* for March 7 and 14, under the title of "The Measurement and Utilisation of Brain-power in the Army," there is a very interesting and valuable synopsis of the work of the American Psychological Section of the Army, which has been under the direction of Major R. M. Yerkes. Within the Army three principal groups of psychologists are recognised: one attached to the office of the Adjutant-General, another to the office of the Surgeon-General, and the third to the division of Military Aeronautics. At first the psychologist was looked upon sceptically, and his *rôle* was supposed to be to assist in the elimination of incompetent neurotics; later, the psychological service was undertaking the assignment of an intelligence rating to every soldier, the selection of men of superior intelligence for special suitable tasks, and the discovery of the intellectually unfit. Very careful tests were chosen, and it became possible ultimately for four psychologists and their attendant clerks to examine one thousand men a day. To supply the necessary *personnel* a school for training in military psychology had to be formed. Although at first even the psychologists were critical about accepting the intelligence rating as a standard of military efficiency, yet as the work progressed it was found that it was the best single factor by which to determine a man's military value. Students of similar intelligence were grouped together for training, thus facilitating the speed and success of the work. It is interesting to note that of all the occupations in the Army the engineering sections contained fewer men of low or mediocre intelligence. It is suggested in the paper that, with suitable modifications, this psychological testing might prove advantageous to problems of civil life.

SIR EDWARD SHARPEY SCHAFER devoted his presidential address to the Edinburgh University Physiological Society last January to the consideration of "The Position of Physiology in Medicine." He showed that it is "the pivotal subject around which all medical sciences are centred, and furnishes the basis upon which the whole of medicine and surgery is founded." While there can be no doubt that the practice of learning physiology before commencing the study of what is founded upon it is correct, yet it is difficult to convince the student of the importance of what he is taught. He is apt to look upon it merely as an examination subject to be forgotten as soon as the test is passed. For this reason it would seem that there might be some advantage in allowing the student to see something of hospital work at the commencement of his physiological studies. A very short, properly planned, special course would suffice if the interest of the hospital staff could be enlisted. This should be less difficult since the importance of physiology has become so manifest in the war. It is pointed out by Sir Edward Schafer that clinical teaching should be in the hands of those who have a thorough knowledge of physiology, whereas it is comparatively rare to find a medical man who realises how dependent he is on physiological work. It is also strongly insisted upon in this address that practical work is of the greatest importance in the proper understanding of the subject, notwithstanding its cost in apparatus, buildings, and staff. This leads naturally to the emphasising of the vital necessity of generous aid to universities on the part of the State.

SOME details of British survey work on the Western front are given by Lt.-Col. H. S. L. Winterbotham in the *Geographical Journal* for April (vol. liii., No. 4). The field survey department grew with the growth of the armies and the new methods of warfare, and managed to meet all the requirements of infantry, artillery, and air force. The existing maps at the beginning of the war were the French 1/80,000, and the plans around fortresses of 1/20,000. In addition, there was a survey on a scale of 1/2500, which was originally made for revenue purposes, and kept in manuscript in the capital of each province: some of these were captured by the Germans early in the war. When trench warfare set in the necessity for a new and accurate large-scale map became apparent. Col. Winterbotham describes some of the difficulties which had to be faced in compiling this map. There was no lack of trigonometrical matter, but it was not easy to reconcile the five systems in existence. The old French triangulation was found to have many defects, not the least being that many of the original fixed points had been destroyed. The Belgian triangulation was perhaps more accurate, but it suffered from the same drawback as regards fixed points. In addition, there were the French Admiralty Survey for the coast, the cross-Channel chain of triangulation made more than fifty years ago, and the new French chain on the Paris meridian and the Amiens parallel. This last survey was connected with the Belgian system with useful results. Difficulty was also experienced in reconciling different data of levels. Col. Winterbotham's paper concludes with some description of how the map was made, and certain other activities of the field survey battalions.

THE Decimal Association has issued a reprint of Mr. Harry Allcock's article on "Industrial Reconstruction and the Metric System" which appeared in the *Electrical Review* of January 17. This is a very able exposition of the case for the compulsory adoption of the metric system of weights and measures. The author urges that, in order to prepare public opinion for the new system, the Government should extend the practice adopted in 1913, when the metric carat was prescribed as the standard weight for precious stones, and abolish forthwith all apothecaries' weights in favour of metric weights throughout the trade in fine chemicals and drugs. Many of the multiples of existing British units should, he maintains, be at once discarded, and all quantities be expressed in terms of single units instead of in cwts., qrs., lbs., etc. As regards the argument that until they became expert in the use of the metric system British manufacturers and merchants would be at a disadvantage as compared with similar classes in Germany, Mr. Allcock points out that this temporary handicap must be faced sooner or later, and that it would be peculiarly opportune to face it now, while the sentiment of the world is decidedly anti-German.

A NEW ferrous alloy with remarkable properties is mentioned in the *Scientific American* for March 1.

The composition appears to be approximately 60 per cent. nickel, 14 per cent. chromium, a little molybdenum, and the remainder iron. It is melted in crucibles and poured into sand moulds. Its tensile strength at air-temperature is 50,000 lb. per sq. in., while at 1800° F. it is still 30,000 lb. It melts at 2800° F., and withstands repeated heatings to 1800° F. and coolings without serious oxidation or diminution of strength. It works well, and can be drawn into wire. It is not acted on by chemicals even when heated, and is already being freely used for the valves and valve-seats of internal-combustion engines and for domestic utensils. The possibility of using the alloy in place of plumbago for crucibles is under investigation, and the results so far obtained are most encouraging. The field of usefulness of an alloy with these properties is obviously extensive, and it is unfortunate that the *Scientific American* gives no hint as to where the material can be obtained.

IN the Proceedings of the Indian Association for the Cultivation of Science (vol. iv., part ii., 1918) Mr. S. Banerji deals with the vibrations of elastic shells partly filled with liquid. The problem here considered is chiefly of acoustical interest in relation to the theory of "musical glasses." This class of instrument consists of a series of thin-walled elastic shells the gravest modes of vibration of which are tuned to form a musical scale by partially filling them with a liquid, and are excited either by striking or by tangential friction on the rims. The principal features of interest requiring elucidation are (*a*) the dependence of the pitch of the vibration upon the quantity of liquid contained in the vessel, and (*b*) the mode of vibration of the liquid itself. These features are discussed in this paper for the three cases in which the elastic shell is respectively (1) a hemispherical one, (2) a cylindrical one with a flat bottom, and (3) a conical cup, these forms approximating more or less closely to those used in practice. The analytical expressions show that the motion of the liquid is very marked near the margin of the vessel, but is almost imperceptible near the centre and at some depth inside the liquid. Numerical results have also been obtained and tabulated, and the graphs plotted, showing the theoretical relations between the quantity of liquid in the vessel and the vibration frequency. The lowering of pitch due to addition of liquid is greatest when the vessel is nearly full.

MESSRS. BERNARD QUARITCH, LTD., 11 Grafton Street, W.1, have just issued a Catalogue (No. 352) of second-hand books and periodicals which they have for disposal. The 1700 odd works listed range over many branches of literature, but the sections relating to natural history and periodicals and transactions of learned societies will appeal more especially to readers of NATURE. In them we notice a set, with supplement, of Gould's "The Birds of Australia," Elwes and Henry's "The Trees of Great Britain and Ireland," Sargent's "The Sylva of North America: A Description of the Trees which Grow Naturally in North America exclusive of Mexico," Butler's "Illustrations of Typical Specimens of Lepidoptera Heterocera in the Collection of the British Museum," R. Bowdler Sharpe's "Hand-list of the Genera and Species of Birds," Edwards's "The Botanical Register" (a set), and long runs of the *Berichte* of the Deutsche Chemische Gesellschaft, the *Quarterly Journal of Microscopical Science*, and the Proceedings and Transactions of the Zoological Society of London. The catalogue is published at 1*s*.

THE following books of science and education are announced for early publication:—"Euclid in Greek" (Book i.), Sir T. L. Heath, and "A Short History of Education," Prof. J. W. Adamson (*Cambridge University Press*); "Practical Vaccine Treatment for the General Practitioner," Dr. R. W. Allen (*H. K. Lewis and Co., Ltd.*); "George Westinghouse: His Life and Achievements," F. E. Leupp (*John Murray*); "Scientific Factory Management," Dr. A. D. Denning (*J. Nisbet and Co., Ltd.*); "Gas and Oil Engine Operation," J. O'Kill (*Sir Isaac Pitman and Sons, Ltd.*).

OUR ASTRONOMICAL COLUMN.

THE APRIL METEORS OF 1919.—Observations were obtained at Bristol on the nights of April 18, 20, 21, and 22, but the display was by no means a rich one. The night of chief activity was April 21, when fourteen meteors were recorded between 8h. 40m. and 11h. 35m. G.M.T. Of these, nine were Lyrids and indicated a radiant point at 272°+30°. Several fine meteors were observed on this night, and particularly at 9.30 and 9.40 G.M.T. The first of these appeared as bright as Sirius, and slowly floated from 236°−1½° to 246°−2° in about 5 secs. This must have been a fine object as seen from the eastern counties of England. The second was one of the true April meteors, with a bright streak, and moved swiftly from 297°+65° to 31°+47½°. It was of about the same apparent magnitude as Jupiter.

THE METEORIC SHOWER OF HALLEY'S COMET.—The celebrated comet of Halley has an accompanying meteor system. The shower was discovered in 1870 by Capt. G. L. Tupman, and shown by Prof. A. S. Herschel, a few years later, to exhibit a significant resemblance to the cometary orbit. The meteors are visible in the mornings of the first week in May, and their flights are directed from a point near the equator in R.A. 337° in Aquarius, and close to the stars ζ and η in that constellation. The meteors have not been witnessed in the same splendour and abundance as those of November from Tempel's and Biela's comets, but they are individually very fine objects, traversing long paths extending occasionally over half the visible firmament, and worthy representatives of the notable comet from which they are derived.

The reappearance of this shower is now due, and it is very desirable that a watch for its meteors should be maintained on the next few mornings. We want more data with regard to its duration, whether or not the point of radiation moves eastwards, like that of the Perseids, and what annual differences affect the number of meteors appearing. Double observations of identical objects will be valuable as enabling their heights and velocities to be determined. The materials already acquired affirm that the observed motion is decidedly slower than that implied from theory, and this is probably due to the resistance of the atmosphere. The radiant does not rise until the morning twilight is in evidence, and when a short period only remains available for observation.

Heis, so far back as May 2, 1848, witnessed a rich display of streaking meteors, and this may quite possibly have been an early return of this system.

OCCULTATION OF STARS BY VENUS.—Mr. Arthur Burnet, honorary secretary of the Leeds Astronomical Society, who has achieved success previously in predicting phenomena of this kind, writes to us from France that the stars 79 Leonis, magnitude 5·5, and B.D.+2·2422°, magnitude 8·6, No. 6927 in the d'Abbadia Catalogue (1900), will be occulted by the planet Venus on August 1 next as seen from certain places in the southern hemisphere. Geocentric conjunction of the planet with 79 Leonis will take place on August 1d. 8h. 54m. G.M.T., and the occultation may be seen from South America. Mr. Burnet computes that the duration of the occultation as seen from Rio de Janeiro will be about nine minutes.

Venus will be in geocentric conjunction with the second star on August 1d. 18h. 40m. G.M.T., which is 6h. 10m. in the evening of August 2 by New Zealand standard time, and it is computed by Mr. Burnet that the occultation, which will be of twenty minutes' duration, may be seen from that part of the globe.

CIVILIAN AIR ROUTES.

THE ban on civil aviation is raised from to-day, as announced in the House of Commons on April 14, and the Air Ministry has issued details of some of the aerial routes which will be declared open. The routes are to be regarded as provisional, since

Air routes and stations. Reproduced from the *Times*.

experience alone can decide upon the arrangement of aerodromes which is most suitable for carrying out the aerial business of the country. The accompanying map shows the routes and aerodromes which have so far been decided upon.

At the date of the armistice there were 337 aerodromes and landing grounds in the British Isles. About 100 will be required for the Royal Air Force, while 116 have already been relinquished for cultivation and other purposes. This leaves about 120 aerodromes, some with extensive accommodation, which will ultimately be available for civilian purposes. It is considered probable that many of these will eventually be acquired by public bodies and commercial firms, and a list will shortly be issued giving particulars of the aerodromes in question, with the facilities they possess and their distances from important centres, in order to assist intending purchasers.

The main routes at present outlined are summarised below, the London terminus being situated at Hounslow:—(1) London–Scotland; (2) London–Dublin; (3) London–Manchester–Belfast; (4) Continental route *via* Lympne; (5) Dutch route *via* Hadleigh; (6) Scandinavian route *via* New Holland; (7) London–Plymouth; and (8) London–Bristol.

The various aerodromes along these routes are clearly shown on the map, and when any route has been declared open pilots using it will find petrol, accommodation, and, where possible, mechanics to handle their machines at each of these aerodromes. Such pilots must, of course, comply with the regulations as regards licensing and inspection of machines.

The Government makes no promise of help to aviators who descend, whether by choice or by force of circumstances, at places other than the official "air stations."

It has been decided to limit the overseas traffic for the present to four "appointed" aerodromes. Three of these will be those named under routes (4), (5), and (6) of the above list, while the fourth will be at Hounslow in order to facilitate direct communication between London and the Continent. These arrangements are, again, only provisional, the problem of the control of overseas traffic being a particularly difficult one, so that it is impossible to fix definitely the Customs stations at the outset.

Rigid supervision with regard to the construction and airworthiness of machines intended for passenger services will be insisted upon, but progress will not be hampered by any inspection of inventions or of purely experimental machines.

It is very encouraging to see the situation so well in hand, and, with the assistance that the Government proposes to give to civil aviators by means of the above scheme, commercial aviation will receive an excellent start in this country. There seems little doubt that full advantage will be taken of the facilities offered, and, in view of the experience gained during the war in the theory and practice of aeronautics, the development of the purely commercial machine should be even more rapid than that of the military aeroplane has been. It is very difficult to attempt a forecast of the future of commercial aviation, but the enterprise invited by the present announcement of the Air Ministry may be expected to provide experience which will very soon give a clear indication as to the possibilities of commercial aircraft.

FORESTRY RESEARCH IN SWEDEN.[1]

THE Swedish Institute of Experimental Forestry, which occupies itself with systematic studies in sylviculture, the botany of trees, forest mensuration, and applied entomology, acquired new buildings near Stockholm in May, 1917, which will add much to its efficiency. The institute continues to publish excellent memoirs on these subjects. The combined volume, Nos. 13 and 14, of 1916–17 contains more than 1300 pages of Swedish text, supplemented by short

[1] Memoirs of the Swedish Institute of Experimental Forestry. Nos. 13–14, pp. 1301+clxxii. (Stockholm, 1916–17.) Price 18 kronor. Also No. 15 pp. 288+xxxii. (1918.). Price 4.50 kronor.

abstracts in German, French, or English. These memoirs are profusely illustrated, and replete with statistics, tables, diagrams, and maps.

To the British forester the most interesting of these studies is the monograph on the cultivation of the larch in Sweden by Prof. Gunnar Schotte, which takes up pp. 529–840, followed by twenty-six pages of bibliography, enumerating the books and articles on the larch in various languages. The botanical part is excellent, but the great merit of the work lies in the admirable account of the sylviculture of the three species which are grown in Sweden. Of the European larch forty-two experimental plots have been exhaustively studied, and most of the conclusions arrived at are applicable to British conditions. Prof. Schotte only approves of pure woods of this species on exceptionally good soils. He recommends a mixture of European larch with pine or with beech on moderately good to medium soils, and is convinced that larch should never be planted on poor ground. For the prevention of canker due to Peziza, which is the scourge of this species in Sweden as well as in England, he advocates early, frequent, and heavy thinnings, with the object of removing the feeble and suppressed trees, which are liable to be attacked by the fungus. The Siberian larch, which is comprehensively treated, is successful in Sweden, but quite unsuitable for our climate. Sample plots of Japanese larch in Sweden are still young, but so far this tree is extremely vigorous and immune from disease. Prof. Schotte's article, which is accompanied by an abstract in English, is followed by a report (pp. 841–922) of an elaborate investigation by L. Mattsson on the form of the stem of the larch. The results, which are highly technical, are also given in an English abstract.

A similar investigation (pp. 9–110) by Nils Sylven of the variety of the common pine which is indigenous in northern Sweden is of considerable interest. This tree, distinguished by some botanists as a separate species, *Pinus lapponica*, differs mainly in its more slender pyramidal crown of foliage and in its thinner bark. The plate showing the variations in the form and colour of the seeds and cones of this variety and of the common pine is beautifully drawn. The germination of the seed of the northern pine is dealt with by E. Wibeck in a memoir (pp. 201–34). The insects which attack the cones of the pine and of the spruce as well, and the peculiar fungus, *Melampsora pinitorqua*, are dealt with in separate articles (pp. 1077–1204).

The composition of forest soils and the formation of humus have been investigated by H. Hesselman (pp. 297–528 and 923–1076). Mr. Hesselman distinguishes mild humus usually found in broad-leaved forests, and raw humus characteristic of most coniferous forests. In the latter no nitrification ordinarily takes place, and natural regeneration is rendered difficult by the feeble growth of the seedlings in the absence of nitrates. He also points out the measures which can be adopted to transform the raw humus, such as partial felling, which admits light on the ground and brings about a radical alteration in the bacterial flora. The change undergone by the humus is accompanied by an alteration in the ground vegetation. When the nitrogen is transformed into nitrate, plants like raspberry, *Epilobium angustifolium*, *Senecio sylvaticus*, etc., appear. In the absence of this transformation, *Aira flexuosa* is the predominant plant in the clearings of the forest. Hesselman's investigations are of considerable interest to ecologists.

The fifteenth volume of the memoirs, just received, contains a number of miscellaneous articles: on a new plough designed by Mr. Widen; on the seed crop of the principal trees of Sweden during 1917; on the attacks of the more important insects and of the fungus *Melampsora pinitorqua* during the same year; and on a new method of ascertaining the form and volume of single stems of spruce. The programme of the investigations to be carried out by the institute during the triennial period, 1918–20, is also given.

PLANTATION RUBBER RESEARCH.

MESSRS. EATON, GRANTHAM, AND DAY have published (Department of Agriculture, Federated Malay States: Kuala Lumpur) an account of important researches carried out in Kuala Lumpur, Malaya, during the last three and a half years in connection with the preparation and vulcanisation of plantation rubber. The Bulletin runs into 398 pages, and gives one of the most detailed accounts of rubber research in Malaya yet published. The authors point out that they, as Government officials, are working under difficulties in so far that, whereas they give full publicity to their methods and results, they are precluded from gaining knowledge of the methods adopted or apparatus used by other technologists in Malaya and London who are carrying on similar experimental work with rubber. It is clear that the policy of secrecy adopted by companies and associations which privately employ chemists and mycologists in the East is open to very grave objection. The policy of secrecy is not only against the true scientific spirit, but must also, in the long run, seriously reduce the value of research even to those who privately employ their own technologists. All scientific work should be open to criticism based upon knowledge of the method and apparatus employed. The present unsatisfactory arrangement may work well enough for privately employed technologists who have the advantage of studying detailed accounts of methods employed by Government officials; the reverse, however, is obviously not the case.

Considerable energy appears to have been thrown into the researches on variability of plantation rubber, a subject which raises hostility among owners of plantations who consider that their finished product cannot be improved upon. We have never agreed with those plantation producers who refuse to believe in the variability of plantation rubber, and the fact that they have introduced the word "uniformity" in a comparative sense does not blind us to the real position.

The authors, as a result of their work, believe that the ordinary forms of smoked sheet and crêpe, now so common in the markets of the world, will be superseded by a new type of rubber turned out in "slabs." If it is true that the rubber prepared in slabs is superior to the common forms now produced, a great advance will have been made.

The problem of vulcanisation has been investigated in an unusual direction. It is claimed that in connection with organic vulcanisation accelerators a discovery has been made which ranks only second with the original discovery of vulcanisation by Goodyear and Hancock. The authors have demonstrated that valuable vulcanisation accelerators are present in Hevea latex, and can be formed by special treatment of the coagulum. A number of vulcanisation accelerators were sent by the present writer to these investigators in 1915; they appear to have led to an interesting line of research which should have far-reaching results. The discovery of the vulcanisation accelerators in Para rubber was made prior to the authors' knowledge of the discovery and use of patent organic accelerating agents. The accelerator found in rubber is said to be produced by the decomposition of the proteins, and to consist probably of an amino-acid or amine. The substances found in plantation rubber are responsible

for variability in rate of vulcanisation. In addition, the authors point out that this variability in respect to rate of cure exists in technical mixings with which manufacturers load the rubber. These mixings are largely mineral constitutents in addition to sulphur. It is further contended that the use of strong accelerating agents, such as oxide of lead, tend to obscure the differences produced in raw rubber by the presence of a natural accelerator.

Recommendations are made to planters which, if adopted, should considerably reduce variability. They are:—

(1) Dilution of latex to a constant rubber content.

(2) The use of acetic acid or other weak organic acid (such as formic acid) as a coagulant.

(3) All coagulating-tanks should be standardised so that the final rubber sheets or crêpe are of the same thickness after rolling.

(4) Conditions of drying and smoking, especially during the early stages, should be kept as uniform as possible.

It is pointed out that if sheets of rubber are of varying thicknesses the rates of drying will be different, and, consequently, there will be more variation in the biological changes which take place during the early stages of drying rubber. H. W.

THE SENSITIVENESS OF PHOTOGRAPHIC PLATES TO X-RAYS.[1]

ALTHOUGH observations have been published on the effect of X-rays on photographic plates, the constants of various plates in use do not appear to have been determined. These experiments follow the standard methods of sensitometry of photographic plates to light in respect of exposure of the plate in strips, of development at a standard temperature and for a constant period (namely, hydroquinone at 20° C. for four minutes), and of the subtraction of the density of a fog strip. The density, *i.e.* the logarithm to the base *e* of the ratio of the intensity of the incident to that of the transmitted light, was determined by a polarisation photometer.

The "exposure" E is defined by the relation $E=V^2it/d^2$, where V, volts, is the pressure applied to the Coolidge tube; *it*, coulombs, the quantity of electricity passing through the tube during the exposure of *t* seconds; and *d*, cms., the distance of the focal spot from the photographic plate. This expression gives the energy of the incident rays. Three values for V were used—31,500, 73,000, and 83,000. The current varied between 0·03 and 0·06 milliampere, which is lower than the currents ordinarily used in radiography. Experiments are in progress using higher intensities of radiation.

When the density, D, for a given plate is plotted against the logarithm of the exposure as above defined, a curve similar to those of Hurter and Driffield is obtained. For densities from 0 to about 1 the curve is convex to the log E axis; above that it is straight to densities of 4, the maximum measured. The intercept on the log E axis of the straight line produced backwards is the logarithm of the inertia of the plate, which was found to be independent of the development. This result is the same as for exposure to the visible light. The slope of the straight portion of the curve gives the contrast. A high value for the contrast is one of the desirable properties of an X-ray plate. The "speed" of a plate may be tentatively defined as the reciprocal of the exposure required to produce a density of 5.

[1] Abstract of a paper by Miss N. C. B. Allen and Prof. T. H. Laby read before the Royal Society of Victoria on August 8, 1918.

The density produced in a given plate was found to be constant for a constant value of the exposure V^2it/d^2 over the range V 31,500 to 83,000, and for a limited variation of *i* and *t*, but not for a large variation of *i* and *t*. This means that, for the wave-lengths used, the density of a plate depends, not on the wave-length, but only on the energy of the X-rays.

Plate	Inertia	Contrast	Speed
Paragon ...	$0·74\times10^3$	2·4	0·00017
,, ...	1·18	2·3	0·000096
Diagnostic ...	0·71	2·2	0·00015
Sunic	1·00	2·35	0·00012
Seed	1·12	1·9	0·000066
Wratten	1·95	2·2	0·000052
Wellington ...	1·70	2·0	0·000050
Imp. X-ray ...	1·26	1·6	0·000036
Cramer	2·14	1·9	0·000035
Ilford	2·19	1·9	0·000033
Imp. S.R. ..	1·45	1·55	0·000028

RAINFALL VARIATIONS.

AT the meeting of the Royal Meteorological Society held on April 16, two papers on variations of rainfall were read. The papers are summarised below.

Mr. A. A. Barnes, in his paper on rainfall in England, the true long-average as deduced from symmetry, stated that it has been usual to assume that the average annual rainfall during any period of thirty-five years can be adopted for obtaining the "long-average" at any rain-gauge, but he considers that the fluctuations which occur between such averages for various thirty-five-year periods tend to show that the basis is somewhat uncertain. By an exhaustive analysis of the annual readings at thirty-eight rain-gauges in England during the sixty-two years 1856–1917, he shows that variations of as much as 5 per cent. on each side of the mean are quite possible when dealing with successive thirty-five-year periods. From these same records it is then shown that far greater consistency in the value of the average can be obtained by taking periods symmetrical about the end of the year 1886. Both by means of tables and diagrams Mr. Barnes shows that that date is a very critical one in regard to rainfall in England, and that, as a rule, the years before that date were relatively far wetter than years subsequent to it. Hence the balancing of the earlier wet years by the later dry years establishes the principle of symmetry about that date, and it is shown that by this method the maximum departure from normal which results from taking each of the fifteen long periods symmetrical to the end of the year 1886 does not exceed 1 per cent. in the case of any of the thirty-eight gauges which were examined.

Mr. C. E. P. Brooks's paper was on the secular variation of rainfall. In order to obtain a measure of the secular variation of rainfall during the past thirty to fifty years, correlation coefficients were worked out between the annual rainfall at each station and "time," the measure of the latter being the number of years before or after the middle year of the series. This was done for 162 stations distributed over the globe, and the results were charted on a map. This map shows that the greater part of the world is divided among a few definite regions of wide extent, in each of which the rainfall has been either increasing or decreasing. The most important area of increasing rainfall is temperate Eurasia (except the western sea-board); other areas are south-east South America and the south of Australia. Areas of decrease are the tropical regions as a whole, South Africa, and the west coast of Europe. It is noted that the number

of sun-spots, and also that of solar prominences, during the period in question have been decreasing. For a few stations records of longer period are dealt with, giving indications that the results obtained are due to a periodicity of upwards of fifty years.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. F. Soddy, F.R.S., professor of chemistry in the University of Aberdeen, has been elected to the second chair of chemistry recently established in the University.

Dr. F. A. Lindemann has been appointed to succeed Prof. Clifton in the chair of experimental philosophy. Dr. Lindemann graduated Ph.D. in the University of Berlin in 1911 by a thesis on specific heats at very low temperatures, such as become possible by the use of liquid air, and much of his early work was connected with that subject. Afterwards in Paris he collaborated with the Duc de Broglie and other French physicists, especially on the subject of radio-activity. During the war he was attached to the scientific side of the Air Service, and was in charge of the laboratory of experimental physics at Farnborough.

The late Dr. Henry Wilde, whose death occurred recently at the age of eighty-five, was a notable benefactor of the University. He was the founder of the Wilde readership in mental philosophy, of the Wilde lectureship in natural and comparative religion, and of the John Locke scholarship in mental philosophy.

Among the lectures announced in connection with the school of geography are courses on physical geography in its relation to the life of man (Mr. Beckit), extra-tropical Africa (Miss MacMunn), geographical factors in the economic development of British North America (Mr. Cossar), and the geography and ethnology of the eastern Mediterranean (Prof. J. L. Myres).

The committee for anthropology announces courses on ethnology (Miss Czaplicka), comparative technology (Mr. H. Balfour), and informal instruction on the Bronze and Early Iron ages (Mr. Leeds), questions relating to ancient Egypt and Babylon (Mr. Griffith and Mr. Langdon), Indian archæology (Prof. Macdonell and Mr. Vincent Smith), and primitive language in its relation to thought (Prof. J. A. Smith).

Dr. Marett will lecture on primitive law, and hold classes on primitive religion in relation to morals and on ethnological questions.

MR. W. M. JONES has been appointed lecturer in physics at the University College of North Wales, Bangor.

CAPT. W. A. ANDREWS has been appointed lecturer in wireless telegraphy at the Cardiff Marine Technical School. He has hitherto been an inspector of wireless operators in connection with the R.A.F.

THE following special lectures have been arranged for delivery in the Metallurgical Lecture Theatre of the Royal School of Mines, South Kensington, at 4 o'clock each day:—"The Smelting of Zinc Ores," J. C. Moulden (May 1); "Sulphuric Acid Manufacture," R. Curtis (May 6); "Factors in Mineral Flotation," H. L. Sulman (May 13 and 15); and "The François Cementation Process," H. F. Marriott (May 20). Admission to the lectures is free to all.

MR. LAWRENCE PHILIPPS has offered University College, Aberystwyth, the sum of 10,000*l.* to found a plant-breeding institute for Wales in connection with the agricultural department of the college. He has guaranteed a further sum of 1000*l.* per annum for ten years towards the maintenance of the institution. The governors of the college have appointed Mr. R. G. Stapleton, who was for some years connected with the college as advisory botanist, to a chair of agricultural botany and to the directorship of the new institution.

DR. J. E. M. FINCH, who died on February 5, bequeathed 5000*l.* to "the Mayor, Aldermen, and Burgesses of Leicester for the endowment of a university for Leicester in remembrance of his long services as medical superintendent of the Borough Asylum." It is understood that the bequest is for the East Midland University, with which Leicester is to be associated, and the seat of which will be University College, Nottingham, as described in an article in NATURE of February 13.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, April 9.—Mr. G. W. Lamplugh, president, in the chair.—W. **Whitaker**: The section at Worms Heath (Surrey), with remarks on Tertiary pebble-beds and on clay-with-flints. (With petrological notes on the beds at Worms Heath by G. MacDonald **Davies**.) The chief pit now shows a fine set of more or less vertical pipes in the chalk, filled with pebbles and sand of the Blackheath beds, separated from the chalk by clay-with-flints. The pebble-beds here, like those elsewhere, consist of well-rolled black flint-pebbles, amongst which pebbles of a brownish quartzite are occasionally found. It is concluded that the water in which these flint-pebbles were formed touched no other firm rock than chalk; but, as there are no sub-angular flints, the deposition of the beds cannot have taken place close along a chalk coast. From a consideration of older Tertiary pebble-beds it seems that these are not big enough to have afforded the material for the Blackheath beds. On the other hand, the Blackheath beds may have yielded the pebbles of the Bagshot series in Essex, though not in Hampshire. As to the clay-with-flints, it is inferred that it is not a deposit of definite age, but a residual product, representing a condition of things that may have held through long geologic ages, from the start of the Blackheath beds to the present time. Mr. G. M. Davies gives a petrological description of the chalk, of the clay-with-flints (both grey and red), of the Eocene sands, sandstones, and pebble-beds.

Mathematical Society, April 24.—Mr. J. E. Campbell, president, in the chair.—K. **Ananda Rau**: (1) Lambert's series. (2) The relations between the convergence of a series and its summability by Cesàro means.—G. H. **Hardy** and J. E. **Littlewood**: A Tauberian theorem for Lambert's series.—Prof. W. H. **Young**: A formula for an area.

MANCHESTER.

Literary and Philosophical Society, April 1.—Mr. W. Thomson, president, in the chair.—S. **Lees**: The superposing of two cross-line screens at small angles, and the patterns obtained thereby. The author discusses in this paper the general characteristics of the patterns obtained on superposing two half-tone plates of like type at small angles θ. More particularly the cases of (i) intaglio, (ii) ordinary half-tone, (iii) "chess-board" screens are discussed. In each of these cases it is shown that the coarse square framework which arises is similar in type to that of each of the constituent screens.—Lieut. W. A. **Macfadyen**: Electrolytic iron deposition. The work described was undertaken with the view of obtaining data on which an industrial process could be built up for the purpose of salving worn steel parts by electro-plating

them with iron. An aqueous solution of ferrous ammonium sulphate was the electrolyte used, and it was found that, whilst excellent results could be obtained from dilute solutions at the normal room temperature, deposition could be carried out only very slowly; with a concentrated solution, however, equally good results were obtained at about seven times the rate usable in the former case. Varying acidity of the solution proved to have a great effect on the deposits, and the best results were given by an electrolyte made about 0·005 normal with respect to sulphuric acid. By heating the bath to a temperature of 60° C., deposition from a concentrated solution could be carried out satisfactorily at a rate of up to fifty times that which was possible in the case of the dilute cold solution. Iron can be deposited direct on to steel, and subsequent heat-treatment produces an adhesion of the deposit to the basis metal very much better than the best attainable by simple plating, and the deposited iron is much tougher than before treating, although it is considerably softer. Such deposits can also be case-hardened with good effect.

DUBLIN.

Royal Dublin Society, April 15.—Prof. H. J. Seymour in the chair.—Dr. Joseph **Reilly** and E. **Ralph**: The system *n*-butyl alcohol-acetone-water. The production of a mixture of *n*-butyl alcohol and acetone on an industrial scale by a fermentation process has rendered desirable a knowledge of this system. Methods of obtaining the composition of mixtures by a determination of acetone by a modification of Messenger's method, and *n*-butyl alcohol by an adaptation of the method of Verley and Bolsing for hydroxyl estimation, are indicated. It was shown that the percentage composition of mixtures is more readily found by determination of a physical constant, such as specific gravity, together with one chemical estimation. Tables and curves drawn with both rectangular and triangular co-ordinates, giving densities over a wide range of mixtures are recorded. The limits of miscibility of *n*-butyl alcohol and water were experimentally found.

PARIS.

Academy of Sciences, April 7.—M. Léon Guignard in the chair.—G. **Bigourdan**: The large instruments and the work of Le Monnier at the observatory of the rue Saint-Honoré.—E. **Ariès**: Formula giving the density of a fluid in the state of saturation.—G. **Julia**: Some properties of general meromorphic functions.—N. **Kryloff**: Some approximation formulæ based on the generalisation of quadratures.—G. **Guillaumin**: Ram-strokes in mains of variable diameter and formed of conical parts.—L. **Dunoyer**: A route-indicator for aerial navigation by dead reckoning.—E. **Alilaire**: The spontaneous inflammation of mixtures of air and ether vapour. After testing mixtures of air and ether vapour at varying temperatures in presence of a number of catalysts, oxides of iron, copper, nickel, etc., the latter being apparently without influence on the phenomenon, it was found that spontaneous inflammation of a mixture of air and ether commenced at about 190° C. By working in tubes of larger diameter it is probable that this inflammation would take place at a lower temperature. The possibility of accidents in factories where large quantities of ether are used, by contact with pipes containing superheated steam, is pointed out.—MM. **Portevin** and **Garvin**: The formation of troostite at low temperatures in carbon steels and the influence of the temperature of immersion in interrupted tempering. If the tempering of the steel is interrupted by suddenly withdrawing the mass from the cooling-water, the temperature of the steel is called the temperature of immersion. When the tempering velocities are well above the critical velocities, interruption of the tempering causes marked recalescence (80° C.) at temperatures down to 450° C., and troostite is obtained after cooling.—Ph. **Glangeaud**: The volcanic group of the Aiguiller, Monts Dore: its secondary and peripheral volcanoes.—Ch. J. **Gravier**: Pedogenesis and viviparity in the Actinia.—E. **Gravier**: Remarks on the preceding paper.—H. V. **Vallois**: Some characters of the femur of Pithecanthropus.—G. **Bertrand**: The high toxic power of chloropicrin towards certain of the lower animals, and the possibility of employing this substance as a parasiticide. Chloropicrin is readily made on the large scale, is easily stored, and in concentrations of 0·01 to 0·12 gram per litre of air kills the larvæ of various noxious Lepidoptera and Hymenoptera. In solution in water chloropicrin is equally very toxic for infusoria, and will probably be of service for the partial sterilisation of soils.

April 14.—M. Léon Guignard in the chair.—G. **Bigourdan**: The works of Le Monnier on the stars and physics of the globe.—A. **Laveran**: The artificial acentrosomic varieties of Trypanosomes. In 1911 an acentrosomic variety of *Trypanosoma evansi* was obtained by the action of oxazine. This variety has been cultivated through mice since 1911, and in April, 1917, after the 450th passage, these organisms were still acentrosomic, and there seemed good ground for assuming that the disappearance of the centrosome was definite and permanent. In April, 1918 (870 passages through mice), the Trypanosomes still remained acentrosomic, but an examination of the blood of the mice in October, 1918 (the 945th passage), showed a large number of Trypanosomes with well-defined centrosomes. Finally, in January, 1919, after 978 passages, all the centrosomes showed normal dimensions. The result of this long experiment shows the necessity for caution in dealing with a supposed definite new variety produced in a living organism.—M. Bigot was elected a correspondant for the section of mineralogy in succession to W. Kilian, elected non-resident member.—P. **Lévy**: The generalisation of the Laplace equation in the functional domain.—E. **Bompiani**: Quasi-asymptotic curves of surfaces in any space.—S. **Lefschetz**: Abelian varieties.—G. L. **le Cocq**: A very general property of cables used for aerial transport.—P. **Janet**: An electro-technical analogy of sustained oscillations.—C. **Chéneveau** and R. **Audubert**: Absorption by turbid media. Application to the estimation of suspensions.—P. **Vaillant**: Polarisation with alternating current.—F. **Michaud**: The mechanical and osmotic action of radiant energy on the media which it traverses.—A. **Kling** and R. **Schmutz**: The characterisation and estimation of carbon oxychloride. A saturated aqueous solution of aniline proved to be the best reagent for phosgene. Diphenylurea is quantitatively produced; this is insoluble in water, and is readily characterised by its crystalline form and melting point. The method may be applied either to the estimation of carbon oxychloride highly diluted with air or in liquid commercial phosgene.—A. **Brives**: The Suessonian in Central Morocco.—P. **Bertrand**: The plant zones of the Coal Measures of the North of France.—P. **Pruvost**: Comparison between the Coal Measures of the North of France and those of Great Britain, according to the succession of fauna.—L. **Dunoyer** and G. **Reboul**: The utilisation of measurements of the velocity of wind at different altitudes for the prediction of barometric variations. When the wind velocity is found to increase with the altitude, a fall of the barometer is to be expected; conversely, if the velocities decrease with the height, the barometer will rise.

—F. **Morvillez**: The leaf-conducting apparatus of the Leguminosæ.—R. **Souèges**: The embryogeny of the Polygonaceæ. The development of the embryo in *Polygonum persicaria*.—F. **Vlès**: The transmission of light through emulsions of bacteria and blood corpuscles.—MM. **Lambert, Vlès**, and **de Watteville**: An opacimeter for use in bacterial estimations. This consists of a photometer of two circuits starting from the same source of light, one traversing the emulsion, the other submitted to a system permitting a variation of the intensity according to a known law. A diagram of the apparatus is given, together with a detailed account of the mode of standardising.—C. **Nicolle** and C. **Lebailly**: Hidden experimental infections. Examples drawn from the study of exanthematic typhus. Examples are given of the inoculation of rats and guinea-pigs with typhus in which there was no sign of the reality of the infection except the transmission of the disease by the blood to another animal. This is a different type from latent infection, as here the disease evolves in the experimental animal with its periods of incubation, infectious state (septicæmia and virulence), and cure, with no sign that can be noted by the observer. The name *infections inapparentes* is proposed for this class. There seems no reason to suppose that such facts are applicable to typhus only.—E. P. **Césari**: The maturation of the sausage. The ripening and flavour of sausages are due to the action of yeasts, three new species of which have been isolated.

BOOKS RECEIVED.

From Nebula to Nebula; or, The Dynamics of the Heavens. By G. H. Lepper. Fourth edition. Pp. 401. (Pittsburgh, Pa.: G. H. Lepper.)

Lowson's Text-book of Botany (Indian Edition). Revised and Adapted by Bubal Sahni and M. Willis. New and revised edition. Pp. xii+610. (London: W. B. Clive.) 8*s*. 6*d*.

A Contribution to the Physiology of the Fresh-water Sponges (Spongillidæ). By H. van Trigt. Pp. vi+220+vi plates. (Leiden: E. J. Brill.)

The Fundamental Equations of Dynamics and its Main Co-ordinate Systems Vectorially Treated and Illustrated from Rigid Dynamics. By F. Slate. Pp. ix+233. (Berkeley: University of California Press.)

Worlds not Realised. By W. J. Jupp. Pp. 94. (London: Headley Bros. Publishers, Ltd.) 2*s*. 6*d*. net.

Beverages and their Adulteration, Origin, Composition, Manufacture, Natural, Artificial, Fermented, Distilled, Alkaloidal, and Fruit Juices. By Dr. H. W. Wiley. Pp. xv+421+11 plates. (London: J. and A. Churchill.) 21*s*. net.

DIARY OF SOCIETIES.

THURSDAY, MAY 1.

ROYAL INSTITUTION, at 3.—Dr. H. S. Hele Shaw: Clutches.

LINNEAN SOCIETY, at 5.—J. Small: The Pappus in the Compositæ.—Montagu Drummond: Notes on the Botany of the Palestine Campaign: I. The Flora of a Small Area in Palestine.—H. N. Dixon: Mosses from Deception Island.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. C. Chree: Magnetic Storms.

CHEMICAL SOCIETY, at 8.—Prof. J. H. Jeans: The Quantum Theory and New Theories of Atomic Structure.

FRIDAY, MAY 2.

ROYAL INSTITUTION, at 5.30.—Prof. J. W. Nicholson: Energy Distribution in Spectra.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. W. H. Hatfield: The Mechanical Properties of Steel, with Some Consideration of the Question of Brittleness.

SATURDAY, MAY 3.

ROYAL INSTITUTION, at 3.—Prof. H. S. Foxwell: Chapters in the Psychology of Industry.

MONDAY, MAY 5.

SOCIETY OF ENGINEERS, at 5.—C. O. Bannister: Heat Treatment of Steel.

ARISTOTELIAN SOCIETY, at 8.—Prof. J. B. Baillie: The Stereoscopic Character of Knowledge.

TUESDAY, MAY 6.

ROYAL INSTITUTION, at 3.—Prof. A. Keith: British Ethnology—The People of Wales and Ireland.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—*Further Discussions*: G. Hughes: The Electrical and Mechanical Equipment of the All-Metal Cars of the Manchester-Bury Section, Lancashire and Yorkshire Railway.—F. E. Gobey: All-Metal Passenger Cars for British Railways.

RÖNTGEN SOCIETY, at 8 (at Royal Society of Medicine, 1 Wimpole Street, W.1).—Prof. W. M. Bayliss: Silvanus Thompson Memorial Lecture—The Electrical Changes in Active Tissues.

WEDNESDAY, MAY 7.

ROYAL SOCIETY OF ARTS, at 4.30.—J. S. Highfield: The Supply of Electricity.

GEOLOGICAL SOCIETY, at 5.30.—Major Reginald W. Brock: Observations on the Geology of Palestine.

BRITISH PSYCHOLOGICAL SOCIETY (Educational Section), at 6.—Prof. C. Spearman: Mental Tests for Vocational Guidance.

THURSDAY, MAY 8.

INSTITUTION OF ELECTRICAL ENGINEERS (Joint Meeting with the Iron and Steel Institute), at 2.30.—J. Bibby: Developments in Iron and Steel Electric Furnaces.—W. H. Booth: The Booth-Hall Electric Furnace.—H. A. Greaves; Application of Electrical Energy to the Melting of Metals.—R. G. Mercer: Electric Furnaces in the United Kingdom, 1918.—Axel Sahlin: A New Type of Electric Furnace.—Victor Stobie: Large Electric Steel Melting Furnaces.

ROYAL INSTITUTION, at 3.—Dr. H. S. Hele-Shaw: Clutches.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—Annual General Meeting.—Hugh K. Picard: Presidential Address.—H. Standish Ball: The Work of the Miner on the Western Front, 1915–18.

OPTICAL SOCIETY, at 7.30.—Prof. F. J. Cheshire: Presidential Address—Polarised Light.—J. Rheinberg: Graticules.

FRIDAY, MAY 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ROYAL INSTITUTION, at 5.30.—Sir George Macartney: Chinese Turkistan—Past and Present.

MALACOLOGICAL SOCIETY, at 6.—G. B. Sowerby: A New Species of Ampullaria in the Geneva Museum.—Dr. A. E. Boycott: Parthenogenesis in *Paludestrina jenkinsi*.—Tom Iredale: Notes on the Mollusca of Lord Howe Island.

SATURDAY, MAY 10.

ROYAL INSTITUTION, at 3.—Prof. H. S. Foxwell: Chapters in the Psychology of Industry.

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