THURSDAY, APRIL 4, 1918.

GOURSAT'S "COURSE OF ANALYSIS," AND OTHER MATHEMATICAL WORKS.

(1) *A Course in Mathematical Analysis. Differential Equations.* Being part ii. of vol. ii. By Prof. E. Goursat. Translated by Prof. E. R. Hedrick and Otto Dunkel. Pp. viii+300. (London: Ginn and Co., n.d.) Price 11*s.* 6*d.* net.

(2) *Finite Collineation Groups, with an Introduction to the Theory of Groups of Operators and Substitution Groups.* By Prof. H. F. Blichfeldt. Pp. xi+194. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1917.) Price 1.50 dollars net, or 6*s.* net.

(3) *Introduction to the Calculus of Variations.* By Prof. W. E. Byerly. Pp. 48. (Mathematical Tracts for Physicists.) (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1917.) Price 3*s.* 6*d.* net.

(1) THE American translation of Prof. Goursat's "Course of Analysis" will be welcome to those who may be unable to read the original easily. The present instalment covers ground in which the author is an acknowledged adept, and it illustrates his remarkable power of illuminating obscurities and giving charm to discussions which, although unavoidable, are apt to be dull. Thus his chapter on existence theorems is not only a model of rigour, but actually entertaining as well; § 30, on the Cauchy-Lipschitz method, is most instructive, and illustrates the value of a diagram when properly used—not as a vehicle for a sham "intuitive proof," but as an image corresponding to a set of analytical data and deductions. Geometrical imagery of this kind is frequently used throughout, and with the happiest results—especially, it seems to us, in the part dealing with partial differential equations of the first order.

There are some features of special interest in the earlier part, which deals with ordinary equations. As an isolated gem we may note the integration of Euler's equation (pp. 23–28), especially the method which leads to Stieltjes's form of solution. The third part of the chapter on linear equations gives a capital summary of the main results obtained by Fuchs, Picard, and others; illustrations are afforded by the hypergeometric series and Lamé's equation. In the chapter on non-linear ordinary equations of the first order there are a number of valuable results, especially those based on Briot and Bouquet's researches as to equations of the form $(dy/dx)^n = R(y)$, where $R(y)$ is a polynomial in y. Here we have a list of all the cases of this type which can be satisfied by a one-valued function of x, and also—which is more important—a clear proof that there are no others.

Next comes a section on singular solutions, and an Englishman cannot help feeling surprised to find no reference to Cayley here (or, indeed, anywhere else in the volume). Readers should notice the last paragraph of § 71; the point is that, if we equate the p-discriminant to zero, the *normal* meaning of the result is a cusp-locus (or tac-locus, or both) which does *not* yield a singular solution; the reason that mathematical students so often obtain a singular solution from the p-discriminant is that so many equations of the type $f(x, y, p) = 0$ are made up by eliminating a constant c from the equation of a set of algebraic curves $\phi(x, y, c) = 0$, which have an envelope.

The discussion of Charpit's method seems to us to be as good as any that can be put into a text-book. What makes it so unusually clear is that the author proves in a separate article (§ 81) that the condition for the compatibility of $f(x, y, z, p, q) = 0$, $\phi(x, y, z, p, q) = 0$, $dz = p\,dx + q\,dy$, is $[f, \phi] = 0$, where the symbol on the left is that introduced by Jacobi. Later on we have discussions of Cauchy's method (pp. 249–64) and of Jacobi's method (pp. 265–78). It should be added that there is a very brief account (pp. 86–98) of Lie's theory of transformation-groups.

From time to time the author pauses to make a general remark on this or that aspect of his subject, and these *obiter dicta* deserve the most careful attention. For instance: "Although this reduction is not, in many cases, of any practical utility, it nevertheless possesses great theoretical interest, for it enables us to determine just how difficult the problem is" (p. 214). Most text-books on differential equations are very misleading, because they give the student the impression that the subject is very much better understood than it really is. The most simple-looking partial differential equations may baffle the most eminent mathematicians, and it would scarcely be too much to say that there is no extensive *theory* of differential equations except for linear ordinary equations the coefficients of which are of certain specified types. This assertion is not so paradoxical as it looks; all the fundamental functions of analysis (*not* of arithmetic) can be defined by very simple ordinary differential equations; for instance, $\exp(x)$ is that solution of $dy/dx = y$ which has the value 1 when $x = 0$. All the properties of $\exp(x)$ can be deduced from this, and the whole of analytical trigonometry is then only a corollary.

(2) Prof. Blichfeldt collaborated with Messrs. G. A. Miller and L. E. Dickson in a work on finite groups reviewed in these columns on November 23, 1916 (vol. xcviii., p. 225). The present work, dealing with collineation groups, so far departs from abstract group-theory as to choose a special imagery, or, if you will, a drapery, for the sets of abstractions considered. Every group may be imaged as a substitution group; not every group can be represented by a collineation group. So Prof. Blichfeldt has restricted his field of inquiry, and deliberately tried not to use abstract group-theory any more than he can help. For the purpose he has in

hand this has undoubted advantages. One of these is that collineation groups form a very extensive family, which admits of geometrical or quasi-geometrical interpretation. (This book has no figures, but the reader should make illustrative figures and models for himself, and think out the arguments in as geometrical a form as possible.) So far as we can judge, the treatment is sound, though it involves some rather artificial arrangements; *e.g.* chap. ii. contains a good deal of *abstract* group-theory, and so far as we can see, the term "group" in its technical sense has not been anywhere defined, and on p. 31 it seems to be confounded with "set" and "class," which, if meant, is very unfortunate.

The discussion goes as far as linear groups of four variables; there is a chapter on group-characteristics (mainly, of course, after Frobenius and Burnside); there are numerous references, and a moderate number of examples. We hope the book will have a wide circulation; every advance in the theory of groups is bound to result in an advance in many other branches of mathematics.

(3) Prof. Byerly's tract will be useful to those who are interested in the classical problems of the brachistochrone, etc., and also, it may be hoped, to physical students engaged in their first struggles with the Hamiltonian equations, least action, least constraint, and so on. So far as we know, a really good elementary treatise on the calculus of variations has yet to be written; meanwhile, such an outline as this is better than many big and pretentious productions. G. B. M.

MEDICAL HISTORY AND SCIENTIFIC METHOD.

Studies in the History and Method of Science. Edited by Dr. Charles Singer. Pp. xiv+304. (Oxford: At the Clarendon Press, 1917.) Price 21*s.* net.

DURING the last ten years there has been a notable revival of the study of the historical development of medicine by the scientific methods which have been applied to other branches of history. In this country there has been no more active worker than Dr. Charles Singer, who for some time has been employed in unearthing for convenient reference the medical historical treasures of the Bodleian Library. The present volume is the outcome of some of the studies of Dr. Singer and his co-workers, and must be regarded as a notable contribution to certain branches of medical history and evolution. The book is splendidly got up, and in addition to forty-one plates, many of which are excellently reproduced in colour, there are large numbers of figures in the text. It is almost remarkable that such a work should make its appearance in the fourth year of the war, and especially at the moderate price of 21*s.*

The text contains seven articles and studies, most of them of immediate historical interest. Dr. Singer himself contributes two of these, the first a very learned account of the scientific views and visions of Saint Hildegard, the German religious mystic of the twelfth century. From the extensive literature which has collected round this complicated personality, Dr. Singer has managed to create a study of great interest, and has dealt in particular with her views on anatomy and physiology. In his second essay, "The 'Anothomia' of Hieronymo Manfredi," he has dealt with the hitherto unknown account of the body written in manuscript by Manfredi at the end of the fifteenth century. As he points out, this is the most complete post-medieval account of anatomy until we come to the first of the anatomists, Berengario da Carpi, who published his work in 1521. Dr. Singer publishes the whole of the Italian manuscript, and leads up to it with a masterly account of the Early Renaissance anatomy, profusely illustrated.

In his "Blessing of Cramp Rings" Dr. Raymond Crawford writes exhaustively of a treatment of epilepsy which was in vogue for hundreds of years. Although it is often regarded as springing up in the time of Edward the Confessor, it cannot be denied that the idea of applying some kind of constriction to inhibit the convulsions of epilepsy can be traced back to classical times.

One of the most interesting studies is Dr. E. T. Withington's on "Dr. John Weyer and the Witch Mania." Herein are traced the origin and development of the most extraordinary superstition which has ever disgraced the human mind, and led to the sacrifice and mutilation of vast numbers of unfortunate human beings even so late as the seventeenth century. It is particularly remarkable that the witch mania should have reached its height at a time when the Renaissance was in full tide and learning was opening men's minds. Dr. Withington considers that at least two causes co-operated for the development of this madness, viz. the development of heresies and the increasing prominence given to the supposed operations of the Evil Spirit, a doctrine supported by the pronouncements of Pope Innocent VII. in 1484. It was then that the Church called upon the civil powers to exterminate witches, and Europe rang with the cries of the innocents perishing daily on the rack and at the stake. Amidst all the ghastly shambles we have the vision of Dr. John Weyer, of Arnheim, trying to stem the tide of this mania, but with ill-success. Although his great work was published in 1563, the practice of torturing witches progressed or increased, and only finally began to die down in the seventeenth century, being finally extinguished in England so late as the beginning of the eighteenth century.

Mr. Reuben Levy contributes an article on "The 'Tractatus de causis et Indiciis morborum' attributed to Maimonides." This work was said to be by the Jewish philosopher, and was considered to be his chief claim as a medical writer. By a complete examination of the only manuscript known, Mr. Levy proves that it was by another writer altogether, and thus clears away an error.

In his essay on "Scientific Discovery and Logi-

cal Proof," Dr. F. C. S. Schiller argues at great length that one of the main obstacles to scientific progress has been the analysis of scientific procedure which Logic has provided, and he pleads that it should abandon its pretensions to rigour and conclusiveness. A philosophical treatment is also adopted by Dr. J. W. Jenkinson on "Vitalism." Dr. Jenkinson was a distinguished embryologist, who, although forty-three years of age, took his commission and fell only ten days after his arrival at the Gallipoli Peninsula.

MILK PRODUCTS.

Manual of Milk Products. By Prof. W. A. Stocking. Pp. xxvii+578. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 10*s.* 6*d.* net.

THIS book is one of the "Rural Manuals"—a series edited by Prof. L. H. Bailey. It is a very complete treatise on all matters connected with the dairy industry. The general scheme of the book is to bring together in one volume the most recent and trustworthy information upon milk and milk products. In pursuance of this object, Prof. Stocking has quoted the writings of specialists in the various branches, so that the student and the practical man are in a good position to learn what is known on those aspects of dairying which are to them of the greatest interest.

The preliminary chapters deal with the process of milk secretion, and the evidence in support of the various theories is given. The much-debated question as to the effect of food upon the quality of milk is discussed in chap. iii., as are other factors which may also have an effect—particularly upon the fat-content of milk. Owing to the fact that the standard method of estimating fat in the United States is by means of the Babcock test, the chapter on milk testing is scarcely so useful to the British reader.

Of late years the American dairy trade has made great advance in the provision of a supply of clean milk for public consumption. In New York there are three grades of milk and cream, and the regulations governing the sale are quoted, as are also the score cards used in connection with milk inspection. One chapter is devoted to certified milk, which is used almost exclusively for the feeding of infants, the cost of production preventing milk of this class being available for any large number of the general community, much as it is desirable that the high standard of purity should be attained for larger quantities of milk. It is clear, however, that the educational value of the efforts now being made to get a clean milk supply must favourably influence the trade as a whole.

The making of butter and cheese occupies about half the space in the book, and full particulars are given of all the necessary appliances and machinery together with details of operations.

There is no doubt that, with the increased demand for cheese, more milk will be used for the production of the latter important article of food in the future. The standard makes of English cheese, such as Cheddar and Stilton, are dealt with, the former variety in considerable detail, as it has become the chief cheese made in America. Working directions are given for making a large number of other cheeses, such as Gouda, Edam, Camembert, Neufchâtel, cream, etc. There is a chapter dealing with the part played by bacteria in dairying, but this section would have to be supplemented by a knowledge of dairy bacteriology if the best use were to be made of it.

OUR BOOKSHELF.

The Improvement of the Gregorian Calendar. By Alexander Philip. Pp. 30. (London: G. Routledge and Sons, Ltd., 1918.) Price 1*s.* 6*d.* net.

OUR present calendar has many inconveniences: the author's recommendations are limited to the correction of the most serious. Notably, August should give a day to February, reversing the reprehensible change attributed to Augustus. If the day were removed from August in one year and added to February in the following year, no alteration would be involved in the Easter tables. Also the leap-day should come at the end of a year; its present position causes many complications. This might be managed, the author suggests, by beginning the year on March 1. He points out the desirability of making each quarter exactly thirteen weeks. He would have one day in common years and two in leap years that would stand outside the weekly reckoning, which would thus recur exactly every year. This would be a great help in the arrangement of meetings and similar events, their relative positions being invariable, while at present they are subject to shifts of a week. These changes would cause some temporary inconvenience, especially to almanac-makers, but would in the long run be a great simplification. A. C. D. CROMMELIN.

Annual Reports on the Progress of Chemistry for 1917. Issued by the Chemical Society. Vol. xiv. Pp. ix+264. (London: Gurney and Jackson, 1918.) Price 4*s.* 6*d.* net.

THE Chemical Society commenced the practice of issuing a collection of reports on the different branches of chemistry fourteen years ago, with the probable object of supplying to the individual chemist a review of that division of chemistry in which he was particularly interested. At the same time, the book is to furnish the reader with a concise survey of branches in which he has only a general interest. These two objects seem to have been attained with a fair degree of success both in the previous volumes and in the present one. It must be admitted, however, that the chemist who endeavoured to read the book through from cover to cover would run considerable risk of suffering from a severe attack of mental indigestion. This characteristic is, of course, an inevitable result of the compression of a year's material into a com-

paratively brief report, and does not depreciate the efforts of the various contributors.

As outstanding features in the various reports, the following may be mentioned. Considerable space is devoted to the Bragg method of investigating crystals by means of X-rays, both by Dr. Dawson (general and physical chemistry) and by Mr. T. V. Barker (crystallography and mineralogy). An interesting discussion on phosphorescence is included in Prof. E. C. C. Baly's report (inorganic chemistry). Prof. J. C. Irvine contributes a very readable account of the year's researches on the aliphatic organic compounds, whilst homocyclic compounds are dealt with by Dr. F. L. Pyman, and heterocyclic compounds by Dr. A. W. Stewart. More than half of Prof. F. G. Hopkins's report (physiological chemistry) is devoted to the important subjects of "The Alkaline Reserve of the Body" and "Some Aspects of Nutrition." Dr. E. J. Russell writes on the year's agricultural chemistry in his customary lucid manner and emphasises the value of the present co-operation between farm and laboratory.

E. H.

LETTERS TO THE EDITOR.

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A Proof that any Transfinite Aggregate can be Well-ordered.

THE following sketch of a proof which seems to me to be not wholly unimportant is given here for certain reasons of priority. I hope that this short account is not unintelligible.

Hartogs's (*Math. Ann.*, lxxvi., 1915, 438–43) considerations may be generalised without difficulty to an investigation of the consequences of the existence of a least ordinal number which is greater than the ordinal types of all possible well-ordered series that can be constructed out of a given aggregate M. This consideration throws no light on whether or not any one of these series actually exhausts M, unless we assume that of two different cardinal numbers one is greater than the other. Instead of using Hartogs's method, I consider all those parts of M which can be well-ordered, well-order them in all possible ways, so that they form what may be called for shortness "chains of M" (so that the same part in different orders gives different "chains"), and imagine as put on one side all chains which are "segments," in Cantor's sense, of other chains of M.

At this point we must introduce a definition: Given a chain (K) of M, let us say that a class K′ of chains of M is a "class of direct continuations of K" if each member of K′ has K as a segment, and also, if L is any member of K′ of type λ, those members of K′ which are of type less than λ are segments of L. Such a class K′ evidently defines one chain and not a class of independent chains, such as Hartogs considers.

Now, in the above process of imagining, we do in fact have a remainder of chains which are not segments of others; for, if not, all chains of M would be segments of other chains of M, and then we could show indirectly that for any such chain K, any ordinal number γ, however great, and any class K′ of direct continuations of K, there is a segment of K′ of type γ. In fact, if there were not such a segment, there would be at least one definite example of each of γ, K, and K′, such that no segment of K′ is of type γ; and thence we can easily show that not every chain of M is a segment of others. But we can prove (*Phil. Mag.* (6), vii., 1904, 61–75) that there is no series which has segments of any ordinal number γ, however great. Thus there is at least one chain of M which is not a segment of some other. It is easy to prove that this chain exhausts M, and that there is a least type of those of chains that exhaust M. Thence, from the fact that the cardinal number of M is an Aleph, we can deduce Hartogs's theorem, determine the form of the limit that Hartogs was really trying to find, and prove Zermelo's (*Math. Ann.*, lix., 1904, 514–16; lxv., 1908, 107–28, 261–81) "principle of selection."

PHILIP E. B. JOURDAIN.

The Bourne, Basingbourne Road, Fleet, Hants, March 12.

Future Supplies of Laboratory Apparatus and Materials.

I HAVE been looking at my list of apparatus and materials which the chemical dealer tells me must wait until the war is over before they can be obtained from Germany. I regret to say the list is a formidable one; I had to add to it this week. Few in our generation will ever knowingly purchase goods made in Germany if they can be obtained from other countries. We feel that German goods must appear to be smeared with the blood of our relatives and countrymen. I take it that my position is much the same as obtains with the heads of other laboratories in the country. Surely, therefore, it is time our British manufacturers realised that it is not much use tinkering with laboratory glass and porcelain ware, if the thousand-and-one other forms of laboratory apparatus have to be purchased in Germany after the war. It seems reasonable to suppose that the orders for laboratory glass and porcelain ware are bound ultimately to accompany the orders for the other requisites.

X. Y. Z.

Long-range Guns.

BY a slip of the pen, double velocity was said, in my article in last week's NATURE (p. 65), to give double range, instead of fourfold.

At that rate, an increase of the velocity of our gun in 1887 would be required from 2400 to 6000 ft. per sec. to make the range grow from 12 miles to 75.

The rule is, of course, not exact except when air resistance is not taken into account. The 12-mile range would have been nearly trebled if it was not for the resistance of the air.

G. GREENHILL.

1 Staple Inn, W.C.1, March 30.

LONG-RANGE GUNS.

THE appearance of a gun with a range of something like seventy or eighty miles has naturally aroused considerable interest, and the question is often asked as to how such long ranges are attained. The answer is that if the shot is to travel far it must get outside the atmo-

Guns (ordnance)

sphere, or rather to a height where the density of the air is very small, and that it must be started with such a velocity that in spite of the air resistance in the first part of its course, its remaining speed, after having reached the upper air, shall be sufficient for its further progress.

At the surface of the earth and with ordinary projectile velocities (2000 to 3000 ft. per sec.) the resistance of the air is large compared with the weight of the shot, even for a 12-in. projectile, though, of course, this ratio decreases in the proportion of the area to the volume.

In the absence of air resistance, elementary dynamics show that if a projectile (or particle) is started upwards with an inclination of 45° the ranges would be as follows :—

Initial velocity	Range
1000 ft./sec.	11·6 miles
2000 „	47 „
3000 „	106 „
4000 „	188 „
5000 „	296 „

It is evident, therefore, that, if a gun is to carry seventy or eighty miles, the shot must attain a height where the air resistance is very small, with a remaining velocity of between 2000 and 3000 ft. per sec.

If the temperature of the air at all heights were constant, the air itself would extend to an infinite height, the pressure and density being connected to well-known laws. If, on the other hand, the temperature decreases adiabatically with the height (as is found to be the case, at any rate, up to 40,000 ft. or thereabouts), there is a finite limit of about seventeen miles above which no oxygen or nitrogen could exist. Above this height a projectile would experience no resistance, but even a few miles lower the resistance would be small compared with its weight.

By using graphic methods there is no difficulty in deducing the retardation which the shot undergoes in the earlier part of its flight, though these methods cannot be shown in full in this short article.

I have not computed the requisite initial velocity for a 9-in. shot (such as is said to have been used in the German gun), but it must be of the order of 5000 ft, per sec.

Data for air resistance up to this speed will be found in a paper read by me before the Royal Society on May 28, 1908.

To attain this speed a long bore would probably be more suitable than an extra-strong explosive; at least, this is what I found to be the case in my own experiments.

In the statement given above as to ranges *in vacuo* it has been assumed that the trajectory was parabolic. In reality, of course, it is part of a very long ellipse, the projectile, in fact, behaving as a satellite with an eccentric orbit of which the elements can be readily calculated.

A. MALLOCK.

CLOUD FORMATIONS AS OBSERVED FROM AEROPLANES.

THE recent development of aviation has provided a means of observing clouds which is much superior to any hitherto known. A modern aeroplane can reach the clouds in a very short time, and in many cases get above them. Observations of temperature can easily be obtained, and probably humidity observations would present no great difficulties. The "bumps" experienced also give some information as to the nature of the disturbance causing the formation of the clouds.

It is well known that the two most important processes which cause clouds to form are (1) the mixture of layers of air of high humidity and different potential temperature,[1] (2) adiabatic expansion due to upward movement.

The first process is the cause of most horizontal cloud-sheets, and the latter of the most typical cumulus clouds and also of rain-clouds. Many clouds of cumulus and strato-cumulus character are due to both processes combined.

It has not hitherto been clearly understood precisely how cloud-sheets a few thousand feet above the surface are formed. Observations from aeroplanes show that under these cloud-sheets there is always some vertical disturbance and a lapse-rate of temperature (*i.e.* a rate of decrease of temperature with height) which is little below the adiabatic rate for dry air, while above the clouds the air is undisturbed, and there is a marked rise of temperature for a few hundred or a thousand feet above the clouds. The disturbance within and below the clouds is not violent in the case of a horizontal cloud-sheet, and is of the same nature as the eddy motion discussed by Major Taylor[2] with reference to the fogs off the Newfoundland Banks. The disturbance is transmitted upwards from the earth's surface, and consists of a fairly regular distribution of eddies, which do not last long, the disturbed air soon mixing with the surrounding air. The effect of heating or cooling the air at the surface has been discussed by Major Taylor, but the type of cloud-sheet we are now considering is caused rather by the movement of a body of air over a wide stretch of sea where there is not much change of temperature. In the course of time the air up to the height of a few thousand feet is thoroughly mixed, with the result that the lapse-rate of temperature becomes adiabatic and the relative humidity increases with height; in many cases a cloud-sheet forms at the top of the disturbed layer of a thickness usually less than 1500 ft., often less than 500 ft. As the normal lapse-rate for the atmosphere generally is less than the adiabatic, there is an increase of temperature on passing from the disturbed to the undisturbed layer, which renders slow the further upward penetration of the eddy motion.

[1] Potential temperature is the temperature which a specimen of air would acquire if it were brought down, under adiabatic conditions, from the position it occupied to the earth's surface.

[2] See (1) "Report on the Work carried out by the S.S. *Scotia*, 1913," pp. 48-68 (London, 1914), and, also by Major Taylor, (2) "Eddy Motion in the Atmosphere" (*Phil. Trans.*, A Series, vol. ccxv. (1915), pp. 1-26) and (3) "The Formation of Fog and Mist" (*Quarterly Journal Roy. Met. Soc.* vol. xliii., No. 183, July, 1917).

Any meteorological condition which causes a body of air to cover a wide stretch of sea without any irregular disturbance favours the development of cloud-sheets of this type. Fig. 1[3] shows an example of a cloud-sheet which occurred at Brooklands on September 26, 1917, with a well-marked south-westerly current. The clouds extended from 3000 ft. to 4000 ft., and there was a temperature recovery of 6° F. in 200 ft. above them; there was some irregular disturbance near the ground, but not sufficient to disturb the cloud-sheet, where the eddies were evenly distributed. This type of cloud-sheet is most common in quiet winter weather, and the eddies are then not so well marked as in Fig. 1, but are, nevertheless, easily seen, and cause the clouds to be called "strato-cumulus." In anticyclones the air is very warm above the clouds, and in winter the temperature

C. K. M. D.

FIG. 1.—Strato-cumulus at 4000 ft. Rise of temperature 6° F. in 200 ft. above clouds. High clouds of approaching "rain-line" above. Taken, from 6000 ft., Brooklands, 4.30 p.m., September 26, 1917.

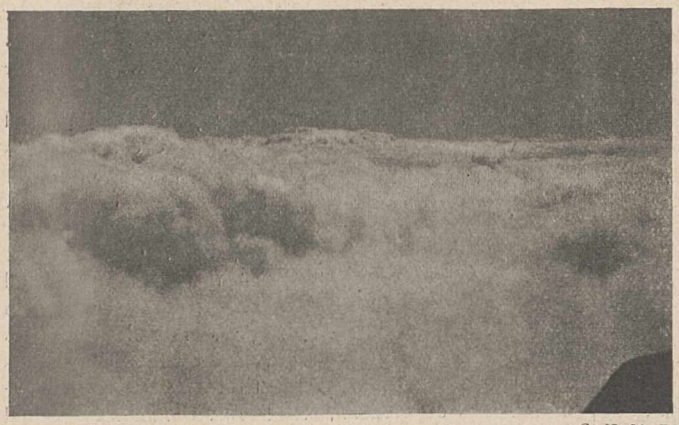
recovery may amount to 15° F. in 1000 ft., as on December 22, 1917, and January 5, 1918, in northern France. Cloud-sheets at these two dates were almost certainly formed originally over the sea; the first was at about 5000 ft., moving from N.N.E., the second at about 4000 ft., moving from W.S.W. For fully 2000 ft. below the cloud-sheets there was much turbulence and an adiabatic lapse-rate, while within 1500 ft. of the ground there was no turbulence noticeable to aeroplanes, and the lapse-rate was zero. Such advances of turbulent cloud-sheets from the sea over the top of comparatively tranquil air near the ground are common in winter in Britain and northern France. Their effect in preventing nocturnal radiation is of great importance.

The clouds of the cumulus class are caused by turbulence on a much larger scale than that which occurs in the horizontal cloud-sheets. They are formed with strong winds or when the air is being heated at the surface, and are commonest over land and on summer days. The winds crossing the irregular surface of the land, or local differences of temperature, give rise to small variations of pressure, which cause irregular vertical currents and corresponding variations in the horizontal wind velocity. The vertical currents do not usually last long, and soon mix with the surrounding air, but the turbulence extends upwards, and thoroughly mixes the air up to the height of a few thousand feet. The turbulence in these conditions is more violent and less regular than that which causes horizontal cloud-sheets. The clouds are due partly to mechanical mixing of layers of different temperature, partly to the adiabatic expansion of ascending air. The form may be cumulus, fracto-cumulus, or strato-cumulus, and the amount depends mainly on the humidity of the layers mixed up. When the turbulence is due mainly to the wind passing over obstacles on the ground, the temperature of the top of the turbulent region is reduced, and a temperature inversion is often formed above the clouds. The irregular disturbances cause the upper surface of the clouds to be uneven, as in Fig. 2, where the variations of the level of the tops of the clouds amounted to 1000 ft. The highest portions of these clouds reached 8000 ft., and the temperature recovery above these portions amounted to 6° F. There was already a thin, broken, horizontal cloud-sheet

[3] [We are indebted to the Scottish Meteorological Society for permission to reproduce the three photographs illustrating Capt. Douglas's paper. They are selected from a beautiful series of thirteen, all taken by Capt. Douglas, which accompany a paper by him on "The Lapse-line and its Relation to Cloud Formation" in the last issue of the Society's Journa Third Series, vol. xvii., No. 34).—Ed. NATURE.]

at 7000 ft., with a slight rise of temperature above it, before it was disturbed by the cumuli rising from below.

On days when the disturbance is due mainly to heating at the surface, and no cloud-sheet or damp layer exists at the height of a few thousand feet, the clouds usually retain the form of cumuli, which are, as a rule, contained within a definite layer the level of which rises during the day. When the clouds have risen to 2000 ft. or more above the surface, the lapse-rate near the ground is adiabatic, but this is not usually the case at the cloud level, with the result that the clouds at the top of the ascending currents are usually colder than the surrounding air, being forced up by small irregularities of pressure. Once the lapse-rate near the ground is adiabatic, large bodies of air may be forced up in this way, forming banks of cumulus clouds. If these enter a layer the lapse-rate of which is above the adiabatic for saturated air, these large cumuli may become warmer than the surrounding air and continue to ascend, and perhaps finally cause showers or thunderstorms. The tops of thunderstorms are seldom below 15,000 ft., and the top of heavy showers usually above 10,000 ft., though if the lower air is very damp, showers may fall from a much lower level. Fig. 3 shows tops of cumuli at about 9500 ft. joined to a shower on the right, and also patches of stratus.



C. K. M. D.

FIG. 2.—Strato-cumulus clouds. Tops 7000 ft. to 8000 ft. Rise of temperature 6° F. in 100 ft. above highest parts. Taken, from about 8000 ft., Brooklands, 11 a.m., August 16, 1917.

We have hitherto only been considering clouds which are due to disturbances originating at the surface. The majority of the upper clouds are entirely independent of superficial disturbances. The same is true of many types of rain-cloud, which are due to upward movement on a large scale; even thunderstorms sometimes develop with their bases at the height of fully 8000 ft., and are independent of disturbances originating at the surface. In many cases rainfall develops over a wide area from high cloud-sheets, which gradually extend downwards as the upward movement becomes more pronounced. The rain area may advance over a wide tract of country, preceded by a high cloud-sheet. The rain-clouds consist of thin mist extending to a great height, and in winter, and at any season above 10,000 ft., they may consist only of thin snow. In France the snow-storm of January 9, 1918, developed from a cloud-sheet of this type, which originally came over high up, and later at lower heights, the snow being finally continuous from the ground to a great height. Rain-clouds of this type may be uniform over wide areas, and there may also be turbulent cloud-sheets near the surface, sometimes joined to the rain-clouds. Sometimes also the lower clouds gather into large cloud-heaps, which cause heavy showers in the middle of the other rain-clouds. The high rain-clouds may themselves be broken into showers by local vertical movements, so

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FIG. 3.—Cumuli, with stratus patches and thin stratus above. Tops of cumuli, 9500 ft.; stratus patches, 8000 ft.; thin stratus above, 10,000 ft. Clouds joined to shower on right. Taken, from about 8500 ft., Brooklands, 2 p.m., August 20, 1917.

that rainfall production is usually a complicated process.

The writer has not had enough high flying to be able to make many observations of the upper clouds, but they certainly present an interesting field of investigation well within the possibilities of aeroplanes. C. K. M. DOUGLAS.

PHOTOGRAPHIC DETERMINATIONS OF STELLAR PARALLAX.[1]

THE determination of stellar parallaxes by photography has shown a striking improvement in recent years, and the results obtained with the Yerkes refractor are of the highest order of excellence. Two of the precautions observed in this and similar series of measures are the taking of all the plates at small hour-angles, so as to minimise the effect of unequal atmospheric dispersion in the stars, and the reduction of the magnitude of the parallax star to equality with the comparison stars. This latter precaution is necessary, since any inequality in the driving will have a different effect on the images of objects that differ much in brightness. The usual way of effecting this is by rotating a screen in the form of a sector of a circle in front of the brighter image. By altering the angle of the sector, any desired diminution of light may be obtained.

This method was used for most of the parallaxes in the volume under notice, which, however, mentions an alternative plan, due to Prof. Kapteyn, that has been successfully tried at Yerkes. It consists in taking an out-of-focus photograph of the required region, which on development exhibits the stars as discs of equal size but unequal density. This negative is then used as a screen for the parallax plate. Since the density of each disc is proportional to the photographic brightness of the star that formed it, it is clear that the use of the screen will give nearly equal magnitudes for the stars on the parallax plate.

The parallax work at Yerkes Observatory was begun in 1903 by Dr. Schlesinger, who was appointed director of Allegheny Observatory in 1905; it was continued by Messrs. Slocum, Mitchell, Lee, Joy, and van Biesbroeck (of the Uccle Observatory, Belgium). Up to the end of 1915 131 parallaxes had been determined. The present volume contains the details of the last eighty-five, and a summary of the earlier results, which have already been published. The parallax stars are mainly bright ones, but nearly one-third of them are faint stars with large proper motions.

The parallax of Algol is given as 0·02″; that of 61 Cygni, 0·27″; of 70 Ophiuchi, 0·21″; of ε Lyræ (the double-double), 0·00″ (all four components being measured); O.A. (N.) 17,415–6, 0·22″. There are six of the eighty-five parallaxes between 0·1″ and 0·2″, three above 0·2″, and seventy-six less than 0·1″. Four of the stars in the trapezium of the Orion nebula were measured, as there is little doubt that they are actually involved in the nebula. The results are negative for all four (−0·014″, −0·026″, −0·021″, −0·023″), presumably indicating that the trapezium and nebula are more remote than the comparison stars. The possibility is recognised that the latter may themselves be involved in the nebulosity, and a further investigation is suggested, using larger plates that would include stars more distant from the trapezium.

The probable errors of these parallaxes are all in the neighbourhood of 0·01″. The error that is reasonably possible is, of course, two or three times as great. A good illustration of this fact is afforded by the parallaxes found for the pair of stars O.A. (S.) 14,318–20, R.A. 15h. 5m., S. decl. 16°. They are 5′ apart, magnitudes 9·6 and 9·2, spectral types G_5 and G_4, P.M.s 3·693″ in 195·7° and 3·675″ in 195·6°, radial velocities +307 km. and +295 km. These striking facts leave no reasonable doubt that the two stars are physically connected, and have sensibly equal parallaxes. The present volume gives for the parallaxes +0·025″ ± 0·008″ and +0·061″ ± 0·012″ respectively. As Prof. H. N. Russell had previously obtained the values +0·014″ ± 0·023″, +0·045″ ± 0·022″, some astronomers have adopted the view that one star is really some three times as distant as the other. But the close agreement of their abnormally large proper motions renders such a conclusion wildly improbable. In fact, the weighted mean parallax is 0·040″ from the Yerkes plates, and 0·030″ from those of Prof. Russell, a quite satisfactory accordance.

An appendix to the volume gives a detailed description of the measuring machine in use for these photographs. It was made by William Gaertner and Co., Chicago. The screw is 18 mm. in diameter, with 249 threads 1 mm. apart. The nut is 50 mm. long, and the graduated head 18 cm. in diameter, having 1000 graduations. The errors of the screw are extremely small.

A. C. D. CROMMELIN.

[1] "Stellar Parallaxes derived from Photographs made with the 40-in. Refractor." Publications of the Yerkes Observatory, vol. iv., part i.

THE SIKKIM HIMALAYA.

NO section of the Himalaya is more fully known than Sikkim; Kashmir even has not been more assiduously investigated. The information regarding Sikkim is important for two reasons. This country, which extends, between long. 88° and 89° E., from the Bengal plain to the tableland of Tibet, is the only fully explored portion of the eastern Himalaya. Our knowledge of the more extensive territories of Nepal to the west, and of Bhutan to the east, is relatively scanty.

The pioneer explorer of this interesting land was Sir Joseph Hooker seventy years ago. Since 1848–49 many others have studied its fauna and flora, its geology and topography, its scenery and people. Explorers, surveyors, collectors, members of political missions, and expert mountaineers have found in Hooker's "Himalayan Journals," published in 1852, a pleasant companion and a

trustworthy guide. Hooker's maps have helped in settling boundary disputes and in conducting military operations.

Artists or climbers who have followed Hooker's path have rarely described their tours; there was little to tell that Hooker had not already told. Scientific travellers have deviated as much as possible from Hooker's track; their writings record facts already noted by Hooker; they less often allude to places he visited.

Among wanderers in Sikkim who have felt the spell of the region and the charm of Hooker's style is Lt.-Col. W. J. Buchanan, C.I.E., who has, in "Bengal Past and Present" (Calcutta Historical Society, vol. xiv.), taken us "In the Footsteps of Hooker through Sikkim and Nepal." The intrinsic value of this interesting article is enhanced by the testimony it bears to the accuracy of Hooker's observations and the soundness of Hooker's conclusions. It forms a fitting and graceful centenary memorial of the great traveller and naturalist.

Besides minor excursions, Hooker made two great Sikkim journeys. During the first—October, 1848, to January, 1849—he explored the upper catchment area of the Rangiet, in western Sikkim, and penetrated some way into eastern Nepal. The second journey—May to December, 1849—took him to the valleys of north-eastern Sikkim, drained by the Lachen and the Lachung, which unite to form the Tista. Wide as Hooker's interests were, he was primarily a botanist, and singularly few of the floral features of the land escaped his eye, especially during the second journey, one episode of which was his capture and imprisonment, along with the Political Officer, Dr. Campbell, by the Rajah of Sikkim.

Much, however, was still left to do. Hooker's friend and fellow-student, T. Thomson, who joined him at Darjeeling, and explored the Khasia Hills along with him in 1850, ultimately succeeded H. Falconer as superintendent of the Royal Botanic Garden, Calcutta, and continued the botanical investigation of Sikkim. T. Anderson, superintendent from 1858 to 1870, did the same.

Hooker, in his "Journals," describes the efforts made to prevent his reaching the Tibetan border. To the energy and tact of Sir G. King, superintendent of the Calcutta Garden from 1871 to 1898, we owe more than the systematic investigation of valleys and passes not visited by Hooker. Though political difficulties prevented King from supplementing Hooker's Nepalese results, he was able to explore the district of Chumbi, which, though politically Tibetan, is geographically Himalayan, as thoroughly as he did Sikkim. Among those whose share in the botanical survey of Sikkim during this period deserves especial mention were W. T. Blanford, C. B. Clarke, H. A. Cummins, D. D. Cunningham, Sir J. Ware Edgar, J. S. Gamble, G. A. Gammie, H. C. Levinge, J. L. Lister, R. Pantling, and Sir G. Watt.

One district, Lonakh, in northern Sikkim, behind the Kinchinjanga *massif*, still remained unexplored. Objection was not taken in 1849 to Hooker's attempt to enter this district, but his party was unable to cut a path through the dense rhododendron forest of the upper Zemu, which blocked the way. Political difficulties frustrated King's wish to explore Lonakh, the "great black south" of the Tibetan graziers, who drive their yaks to its poor alpine summer pastures. An expedition organised by him for the purpose in 1892, under Mr. G. A. Gammie, had at the last moment to be diverted to another district.

This region, difficult of access from the south, was at last traversed by Mr. Freshfield, whose account of his journey, "Around Kanchenjunga," published in 1903, now almost takes the place of Hooker's "Journals." The first Lonakh plants to reach the Calcutta herbarium were sent from the Naku-la by Sir F. Younghusband in 1903. It has been the good fortune of the present superintendent of the Calcutta Garden, Lt.-Col. A. T. Gage, to organise an expedition, led by Messrs. W. W. Smith and G. H. Cave, which in 1909, by investigating this district, has done much towards completing the botanical survey of Sikkim begun by Hooker.

NOTES.

THAT "prevention is better than cure" needs no argument, and yet it may be observed from time to time in the daily papers that the general idea of a Ministry of Public Health seems to be that the various organisations for *treatment* of disease are very specifically involved, and that, provided the interests of these organisations are secured, all might go well. It is only Lord Rhondda who appears to place *prevention* well to the front. Insurance against sickness is necessary where prevention fails, but surely every bed occupied by a sick man or woman is a possible censure upon the prevention side. There are, therefore, two distinct branches of work. Prevention involves the organisation of science, not merely laboratory science, but also the practical applications of the lessons learned in the laboratory, these applications being carried out by scientifically trained men. Treatment involves the reconstruction of our hospital system. If we are to have a Health Ministry and a really national Health Service it is the prevention side that demands, and must receive, the chief attention of our statesmen. For the cure of disease we may justly be proud of our doctors of all ranks. But what is their work? Nine-tenths of it is trying to remedy and cure easily preventable disease. King Edward asked: "If preventable, why not prevented?" and his question has not yet been answered. If the Health Ministry is to be a success its chief aim must be prevention. We who believe in the urgent necessity for a Ministry of Health want to answer King Edward's question, and so to deal with the health of the nation that the next generation will know nothing of preventable disease, or, if it occurs, will regard it as a disgrace, and that the sufferer from any disease the cause of which is known and preventable will be as ashamed to admit it as is now the case with those affections which are known to be the result of excesses and loose living.

FOR several years before the war various branches of science had gradually been acquiring the elements of an international organisation, and in several instances Germany had secured that the central bureaux should be associated with her own national institutions

dealing with the branches of science concerned. These arrangements have lapsed since the outbreak of war, either informally, or, as in the case of the International Geodetic Association, by the non-renewal of the diplomatic convention which had constituted and maintained the association. The convention was originally concluded in 1895, and renewed in 1907 for a further period of ten years, so that it ceased to exist last year. In the course of 1916, however, steps were taken by a group of neutral States—Switzerland, Holland, Denmark, Sweden, Norway, Spain, and the United States of America—to constitute amongst themselves, and under terms resembling those of the old convention, a small association which might maintain the work of the wider body, if only in a restricted form; this neutral group is to dissolve two years after the conclusion of peace. Among other services, it has assured the continuance of the international scheme for determining the variation of latitude. The question of the future of international geodetic work has recently been raised, perhaps a little prematurely, by M. Ch. Lallemand, Directeur du Service du Nivellement de la France. In a letter addressed to the delegates from all the countries of the Entente to the lapsed association, and also published in the *Revue générale des Sciences* (February 28, *Supp.*, p. 17), M. Lallemand advocates the foundation of a new body, to be confined, at least initially, to the Entente countries. With this in view he has sent out a draft of a proposed convention, which, amongst its provisions, departs from former practice in giving voting power to the different countries, not equally, but in some kind of proportion to their relative importance. A special conference will be called to discuss the proposals as soon as occasion offers.

FROM time to time the safety of the numerous prehistoric remains on Salisbury Plain has been a matter of anxious concern to antiquaries in consequence of the use of the Plain by the military authorities. There has been every evidence of goodwill on the part of the military authorities, but their best intentions and endeavours have not been sufficient to prevent a considerable amount of mischief being done. A valuable step in advance has recently been taken at the instance of the Society of Antiquaries by the appointment of Lt.-Col. William Hawley, of Salisbury, the able explorer of Old Sarum, as an inspector to watch over the safety of these remains and report to the War Office any injury with which they may be threatened. It is to be hoped that his authority may be extended in the direction of empowering him to take effectual steps to prevent any such injury. The safety of Stonehenge itself is not so well assured as could be wished. Since it was acquired by a public-spirited citizen of Salisbury it has been placed in the charge of a custodian employed by him, and watched over by a police constable, and for their accommodation two cottages had been provided in the immediate neighbourhood of the monument. For some military reason which has not been disclosed, the authorities have taken over these cottages and ordered them to be demolished. As there are no other cottages in the neighbourhood, the necessary consequence seems to be that the custodian and constable cannot exercise constant supervision as hitherto. The Society of Antiquaries has adopted the following resolution, drawn up by its president, Sir Arthur Evans:—"The Society of Antiquaries has heard with concern that the War Office proposes to demolish the two cottages by Stonehenge, which serve as the domiciles of the custodian and the police constable charged with the safe-keeping of the monument. As these are the only available cottages in the neighbourhood the society feels that such action may be fraught with perilous consequences, and therefore begs leave to direct the attention of the Secretary of State for War to the urgent necessity of taking adequate steps to protect this national monument from injury or defacement."

THE *Times* of March 28 publishes a long Reuter message from Stockholm containing parts of the memorandum on the crisis which led to war drawn up in August, 1916, by the former German Ambassador in London, Prince Lichnowsky. The memorandum decisively fastens upon Germany the responsibility for the war, and is a document of high historical importance, especially if the whole of it represents the British attitude so truthfully as is done by Prince Lichnowsky in the following reference to what is thought of science and learning:—"In no place . . . is an envoy's social circle of greater consequence than in England. A hospitable house with friendly guests is worth more than the profoundest scientific knowledge, and a learned man of insignificant appearance and too small means would, in spite of all his learning, acquire no influence. The Briton hates a bore and a pedant. He loves a good fellow."

MR. H. J. HELM, whose death occurred last week at Bromley, Kent, was for several years deputy-principal chemist of the Government Laboratory, which position he held on his retirement from the public service in 1904. For a considerable period previously Mr. Helm had been a superintending analyst in charge of chemical matters connected with the assessment of revenue, and his technical knowledge of the brewing, distilling, and tobacco-making industries, as also of the legal enactments by which the operations of these industries are controlled, enabled him to render valuable assistance in matters of fiscal chemistry to Sir Edward Thorpe when the latter succeeded the late Dr. Jas. Bell as head of the laboratory. Cautious and shrewd, Mr. Helm had a marked sense of what was reasonably workable in applying laboratory results to industrial practice, and his advice tended always to assist in holding the balance fairly between the interests of the Exchequer on one side and those of the manufacturing and general public on the other. He was of somewhat reserved, but withal kindly, disposition, and the news of his decease, albeit at the ripe age of seventy-nine, will be heard with regret by many friends and official acquaintances.

THE special correspondent of the *Times* at the War Correspondents' Headquarters in France says that information as to the long-range guns which are shelling Paris was obtained last December from prisoners. The guns were said to be of 15 in., and fined down to about 8¼ in. They were, according to one informant, 79 ft. long, and in the trials had carried 75 kilometres, and were expected to carry 100 kilometres, or 62 miles. More remarkable than the gun was the shell, which was 59 in. in length and prolonged into a bottle neck at the front, with two copper driving bands and rifling extending in advance of these, the weight of the shell being about 350 lb. The two copper driving bands are 1 in. wide, and in front of these is a steel or iron band of 3 in. or more, over which the rifling extends, which would give the shell great stability in the air. According to the latest information derived from prisoners, the *Times* correspondent says, the gun's length would probably be about 104 calibres—that is, 104 times the diameter of the bore—which is getting on for twice the length of any gun of the same calibre we make. The muzzle velocity is estimated to be from 4500 to 5000 ft. per second, and it is conjectured that the gun is elevated to an angle perhaps as high as 55°, so that the main part of the path of the shell would be in a region where little air resistance would be experienced.

WE regret to see the announcement of the death of Mr. G. M. Seabroke, director of the Temple Observatory, Rugby.

THE annual oration of the Medical Society of London will be delivered by Dr. T. S. Hyslop on May 13, upon the subject of "Degeneration in Art, Science, and Medicine."

WE learn from the *Times* that at the annual meeting of the Association of Chambers of Commerce to be held in London on Tuesday and Wednesday next a Bill for providing a decimal system of coinage will be submitted for approval. The terms of the Bill have been agreed on by the Executive Council of the association, the Bankers' Institute, and the Decimal Association. Arrangements are being made for its immediate introduction in the House of Lords.

IN the *Museum Journal* (vol. viii., No. 2, June, 1917) there is a remarkable account of human sacrifice among the Mundurucu Indians on the Tapajos River, a tributary of the Amazon. Disease is believed to be caused by a Bokaidpot, or evil genius, in the village. This person is identified by the medicine man, and he is slain if many deaths or much sickness occur. The victim is strangled by means of a cord pulled tightly round his neck, and next morning, after the chief has seen it, the body is cremated. The accused knows he is to be killed and offers little resistance. Two men are appointed to do the deed at the first opportunity; they may select their time, but cannot escape the duty.

MR. T. SHEPPARD, in the *Naturalist* for February, describes a collection of implements of the Bronze age in the Whitby Museum. There are in all twelve specimens, of which two are evidently of Irish origin, and some are imperfect. One rare type of implement, a socketed dagger, is unfortunately imperfect, the blade being broken, and a crude attempt having been made to sharpen the broken part for use as a chisel. Two specimens are obviously forgeries, and seem to be rather clumsy attempts to imitate genuine weapons. These are clearly the work of "Flint Jack," who was a native of the Whitby district, and spent some time there in his later years doing his best to satisfy the demands of collectors.

THE Hon. J. W. P. Murray, Lieutenant-Governor of Papua, has forwarded to Mr. S. H. Ray a vocabulary of the people between the Fly and Strickland Rivers, Papua, which is published in the March issue of *Man*. These people live about Lake Murray, a large, swampy tract which lies in the angle formed by the junction of the Fly and Strickland Rivers, discovered by Messrs. Massy-Baker and Burrows in 1913. The language of these people seems to be closely connected with that of the Merauke or Tugeri tribe, and the tribes connecting the races of these two areas must be sought in the still little-known interior of the island rather than along the coast. In one village stuffed heads, like those found on the Strickland, and described by D'Albertis, were noticed. But the latter was mistaken in believing that the skull was removed through a long cut on the neck; as a matter of fact, the flesh is replaced by clay or fibre; the skull is not removed.

THE volume of Scientific Reports of the Agricultural Research Institute, Pusa, for 1916–17 continues the record of valuable services rendered to Indian agriculture by this institution. The report of the director is accompanied by the reports of the heads of the various scientific divisions, and the matters dealt with are so varied as to preclude any effective summary within the compass of a brief note. A few subjects chosen at random include starch production, soil aeration, wheat-breeding, indigo, paddy diseases, disease-carrying insects, and green manuring. Detailed reports on some of these subjects have been published during the year and noted in these columns.

A BACTERIAL disease of wheat in the Punjab is described by Mr. C. M. Hutchinson in the Memoirs of the Department of Agriculture in India (vol. i., No. 7). In the affected wheat the inflorescence and parts of the stem are covered with a bright primrose-yellow slime, and the growth of the plant may be interfered with and the stem distorted. The appearances are well depicted in a coloured plate. The yellow slime is crowded with bacilli, which can be readily cultivated on a variety of culture media, yielding yellow growths on many. Inoculation of wheat plants with cultures successfully reproduced the disease provided that the plants were kept in an abnormally moist atmosphere. The bacterium is named *Pseudomonas tritici*.

PROPHYLACTIC inoculation against pneumococcal infections is the subject of a research by Mr. F. S. Lister (Publications of the South African Institute for Medical Research, No. x.). He shows that from 63 to 77 per cent. of all cases of pneumonia among the Transvaal native miners are caused by one or other of three races or groups of the pneumococcus designated A, B, and C. By prophylactic inoculation, pneumonia has been completely abolished on the Crown Mines. The method is to administer three subcutaneous inoculations of one cubic centimetre each of a vaccine containing representatives of the three groups, A, B, and C, of pneumococci in equal proportion, and containing seven thousand million cocci per c.c. Details are given for the preparation of the vaccine, and statistical data of the results obtained by its use are tabulated.

THE cessation of the trade in tinned articles of food during the war has forced India to rely on its own resources. An exhibition of such local productions held at Calcutta early in January last shows how much progress has already been made. The sun-drying of vegetables has been undertaken; dried and made into bricks, the weekly supply for a thousand men on active service can be carried in twelve kerosene tins, an easy load for two mules. Biscuits are being largely made of the flour of Pusa wheat; macaroni, vermicelli, and ground rice are made. Hams and bacon come from the Balaclava farm at Ghoom, the produce being sold at little more than half the price of the imported article. Cured and tinned fish and a large selection of condiments are another branch which has proved very successful. The exhibition will do much to encourage this new trade in food for Europeans in India.

THE migrations of the king-fish, or opah (*Lampris luna*), and of the sun-fish (*Orthagoriscus mola*) in British waters are briefly summarised in the *Scottish Naturalist* for February by Prof. D'Arcy Thompson. His analysis of recorded captures of the first-named, all of which were secured with a hook, seem to show that the northern movements of this fish lie in a sort of belt along the edge of the deep water from the eastern side of the North Sea round the Shetlands to the outer side of the Hebrides. This migration unmistakably attains its maximum during the summer months, though there are many records of specimens taken during winter. But these are all inshore records, suggesting that such individuals must be regarded as stragglers which have lost their way. The migrations of the sun-fish show a double maximum, one in early summer for our southern and western coasts, and one in autumn for the east and north. It has been suggested that the sun-fish is, so to speak, a passive migrant, carried along by ocean currents with no "proper motion" of its own. Prof. D'Arcy Thompson is by no means inclined to accept this view. Though he agrees that the great Atlantic "Gulf

Stream" current plays an important part in these movements, he is led to the conclusion that food is the influence immediately at work, these fish preying largely on eel larvæ or "leptocephalids," which, during the summer months, are making their shoreward migration from the Atlantic. "There would seem," he remarks, "to be a close and even precise correspondence between this periodic annual migration of the Leptocephali and the appearance of the sun-fish in our home waters."

MR. E. E. GREEN, in the *Entomologist's Monthly Magazine* for March, makes a plea in favour of the introduction into Great Britain of two species of exotic butterflies. Mischief enough already has been wrought in many parts of the world by experiments of this kind, and it is devoutly to be hoped that further ventures in this direction will not be made without the fullest consideration of the possible consequences.

THE structure and relationships of Bathynella, the European "well-shrimp," are discussed by Dr. W. T. Calman in a recent paper in the *Quarterly Journal of Microscopical Science* (vol. lxii., part 4, 1917). From the study of a few fresh specimens from Switzerland Dr. Calman definitely confirms his long-held opinion that this tiny, blind crustacean is a degenerate member of the Syncarida, where it finds its place together with Anaspides and the remarkable allied genera that inhabit certain Tasmanian and Australian lakes, and Palæocaris and other fossils preserved in rocks of the Palæozoic era.

THE advance of our knowledge about the part played by blood-sucking insects in the spread of disease is of such importance and so continuous that the paper by M. E. MacGregor (*Bull. Entom. Res.*, vol. viii., part 2, 1917), giving a summary of the recorded "Insect Vectors of Disease," will be of value for reference by students. Ticks and other Acarina are appropriately included in the tables, as well as true insects. Mr. MacGregor warns the reader that his lists "can in no way claim to be complete," but the omission of the sheep-flies (*Lucilia sericata*, etc.) from "the chief insects and Acarina that are directly the cause of disease in man and his domestic animals" is somewhat surprising.

IN a recently issued pamphlet, "Zur Auffassung der Verwandtschafts-Verhältnisse der Tiere, I," Prof. J. E. V. Boas, of Copenhagen, speculates on the relations of the Echinoderms. He suggests that they were derived, through the Crinoids, from a sessile polyp, and he adduces in support of his view many interesting resemblances of structure. Sedgwick showed how all animals with a body-cavity distinct from the gut might have originated from the Cœlentera, and the article "Echinoderma" in the "Encyclopædia Britannica" (1902, 1911) applies this in more detail to the Echinoderms. But the direct and easy transition imagined by Prof. Boas fails to explain the peculiar torsion of Echinoderm structure, or the traces of bilaterality the existence of which he is bold enough to deny. Had he remedied his admitted want of knowledge of some English writings on this subject he might have dealt with these difficulties more convincingly. Prof Boas then proceeds to construct an ancestral worm (an "Ur-Chætopod," to be precise), from which he would derive the Nemertines and flat-worms, the Enteropneusta, the Chætognatha, and the Brachiopoda; and he connects this ancestor with the Echinoderms by way of the Holothurian Synapta. He brings out, it is true, a number of interesting analogies, but most zoologists would ascribe these to similarity in the mode of life. A brief final chapter deals with the germinal layers and the development of the cœlom. The author insists throughout that his hypotheses are possibilities rather than proved theories. If they present difficulties even as possibilities, we may none the less be grateful to Prof. Boas for presenting ancient problems in a new light and in a manner that is both interesting and easy to follow.

IN the February issue of the *Scientific Monthly*, published in New York, two interesting articles on meteorology in connection with the war appear. Prof. R. DeC. Ward writes about "Weather Controls over the Fighting in the Italian War Zone," and gives details about the rain- and snow-fall and the temperature during the past three years. The fighting has been chiefly in mountainous regions, and the passes have often been blocked by heavy snow. Prof. Alexander McAdie deals with "Meteorology and the National Welfare." A considerable part of his article is concerned with the prevailing winds, such as the trades and monsoons, and Prof. McAdie points out how the character of a season in the United States depends on the direction of the prevailing wind in that particular season. He shows how aviation will depend upon a knowledge of these winds, and expresses the hope that much information about the currents and temperature of the upper air useful for meteorology will be obtained by aviators after the war. In the same number of the magazine there is also an article on "Snow and its Value to the Farmer" by Dr. Andrew H. Palmer, which is interesting and contains many good reproductions of photographs.

SOME experiments carried out at the Cancer Research Department of the Middlesex Hospital are described by Mr. J. C. Mottram and Dr. S. Russ in a paper in the Proceedings of the Royal Society of Medicine, vol. x. The paper gives a detailed record of experimental observations of a case of carcinoma under radium treatment. An ionisation method was employed to determine the intensity of the radiation emitted by the several applicators used, and, in addition, measurements of the absorption of the β and γ radiations by the skin and subcutaneous tissues were made. This was done in order to be able to compare the effect produced upon the skin when it is irradiated in such a manner that equal amounts of β and γ rays are absorbed by it. Details of the observations on the skin and subcutaneous nodules subjected to screened and unscreened β and γ radiations are given. As a result of the tests it is established that, first, if the skin is irradiated in such a manner that the neighbouring portions absorb equal amounts of β- and γ-ray energy, similar reactions are produced, but they are, in general, more pronounced in the case of the γ rays. Secondly, if the skin is exposed to a large amount of β or γ radiation for a short time the reaction is more pronounced than if the same dose is given using a smaller amount of radium for a correspondingly prolonged period. The effect on the malignant subcutaneous nodules was not, however, appreciably different in the two cases.

THE *British Journal of Photography* has reprinted in its issues for March 1, 8, and 15 a paper on "Axial Aberration of Lenses," by Messrs. Tillyer and Shultz, of the Bureau of Standards at Washington, which has appeared in the Journal of the bureau. After a clear account of the way in which zonal aberration and the sine condition affect the image, the authors describe a modification of the Hartmann method which they have introduced for the determination of the axial aberration of lenses and instruments. In the case of a lens monochromatic light of wave-length 4250, 4750, 5500, or 6500 Ångström units is allowed to fall on a metal screen seven metres away, perforated with holes a millimetre in diameter and three millimetres apart.

The lens is placed immediately behind the screen, and the thin pencils of light which pass through the holes are received on a photographic plate placed at suitable points between the lens and its focus, and beyond the focus. From the subsequent measurements of the positions of the spots of light on the plate curves showing the variation of the effective focal length, the spherical aberration and the coma for each of the four kinds of light used are drawn. Seventeen sets of curves for typical lenses are reproduced in the paper.

THE Institution of Electrical Engineers has issued in pamphlet form the standard clauses for street lighting specifications which are the outcome of the deliberations of the Joint Committee consisting of delegates of the Institution of Electrical Engineers, the Institution of Gas Engineers, the Institution of County and Municipal Engineers, and the Illuminating Engineering Society, and appointed in 1910. The specification prescribes the form of tender, particulars of lighting units, and the general nature of the contract. It is proposed to classify streets in five classes, having respectively a minimum illumination of 0·01, 0·025, 0·04, 0·06, and 0·1 foot-candle, the minimum being measured with a suitable photometer in a horizontal plane 3 ft. 3 in. from the ground. A minority report expresses the dissent of the council of the Institution of Gas Engineers to the proposed basis of measurement, and it is preferred that contracts for street lighting should be based on the average candle-power of the light source ascertained at two or three prescribed angles. The points at issue were dealt with in the discussion of a paper on this subject by Mr. A. P. Trotter before the Illuminating Engineering Society in 1913, but complete agreement was not attained. As the matter has been under consideration for six years it was decided to publish the clauses as they now stand, accompanied by a minority report. It is hoped that they will be found useful when methods of street lighting are reviewed after the war. Copies can be obtained from the secretary of the institution, price 3*d*., post free 4*d*.

THE relation between temperature and the pressure of a saturated vapour is of great theoretical and practical interest, and a very extensive literature already exists on the theoretical side, special attention having been given to the relationship in the case of water and water vapour, and ice and vapour. So far as the vapour pressure of ice is concerned, experimental determinations have been carried out with considerable accuracy in recent years by Scheel and Heuse and others, but there has been a great need for a series of exact determinations of the vapour pressure of ice at low temperatures, in order partly to correct the values obtained by Scheel and Heuse, and partly to see whether the Nernst formula holds good down to the lowest pressures. Such a series of determinations has been carried out with the greatest care by Sophus Weber, working in the laboratory of Prof. Kammerlingh-Onnes at Leyden (Communications from the Physical Laboratory of the University of Leyden, No. 150). The method employed was the ordinary static method in combination with the absolute manometer and the hot-wire manometer of Knudsen. The measurements extend over a range of temperature from about −22° to −190° C., and the values have been compared with the Nernst formula,

$$\log p = \frac{-2611{\cdot}7}{T} + 1{\cdot}75 \log T - 0{\cdot}00210\,T + 6{\cdot}5343.$$

The concordance has been found to be particularly good. By the introduction of a quantum-formula due to Pollitzer, Nernst has made his equation more rational, but so far as agreement with experiment is concerned, there appears to be little to distinguish the two expressions. Incidentally, it may be said, the experiments of Weber show that water vapour at a temperature of −80° has a molecular weight of about 20, whereby partial association is indicated.

THE customary methods for the preparation of plant nucleic acids are rather cumbersome and necessitate a peptic digestion of the nucleoproteins extracted. Messrs. G. Clarke and S. B. Schryver have succeeded in avoiding the peptic digestion, and their method of procedure is described in the *Biochemical Journal* for December. In the preparation of nucleic acid from yeast, the latter, after pressing, is treated with a large excess of 95 per cent. alcohol for twenty-four hours, and then boiled for two hours in the same solvent, whereby the protein-complex is rendered insoluble in sodium chloride solution. The yeast is then filtered, pressed, dried at 37°, ground to a fine powder, and extracted for four to five days with 10 per cent. sodium chloride solution at 60°–80°. When the clear extract is treated with hydrochloric acid a characteristic precipitate of nucleic acid separates and settles to a hard cake at the bottom of the vessel. After standing, this is washed with 50 per cent. alcohol until free from chlorine, left standing overnight in 95 per cent. alcohol, and finally washed with absolute alcohol and ether. The yield varied from 1·4 to 1·6 per cent. of the dry alcohol-extracted yeast. The crude nucleic acid was best purified by dissolution in warm 10 per cent. sodium acetate solution, and reprecipitation with hydrochloric acid. Nucleic acid can be prepared from wheat embryos in a similar manner, but in this case it is found advantageous to remove the starch by hydrolysis with taka-diastase before extracting with sodium chloride solution.

OUR ASTRONOMICAL COLUMN.

INFRA-RED SOLAR SPECTRUM.—By the use of plates stained with dicyanin, Mr. W. F. Meggers, of the Washington Bureau of Standards, has obtained an excellent series of photographs of the solar spectrum in the region from 6800 A to 9600 A (*Astrophysical Journal*, vol. xlvii., p. 1). These photographs thus provide material for accurate determinations of wave-lengths in continuation of the classic tables of Rowland, which did not extend further than the approximate limit of the visible spectrum at 7300 A. Photographs in the same part of the spectrum of more than forty of the chemical elements have also been taken, and nearly 400 of the solar lines have been identified with lines in the spectra of eighteen elements. Two hundred lines are accounted for by iron, sixty-three by nickel, twenty-seven by titanium, twenty-two by cobalt, and smaller numbers by chromium, silicon, manganese, calcium, and other elements. One thousand six hundred lines remain for the present unidentified. In addition to the well-known bands due to terrestrial oxygen, there are others which appear to be due to water vapour. The separation of the solar and telluric lines has been undertaken at the Allegheny Observatory by the solar rotation method. Publication of the wave-lengths is postponed, but reproductions of the solar photographs, with wave-length scales, are included in the paper.

HARVARD COLLEGE OBSERVATORY.—A recent report of the committee appointed to visit and report upon the Harvard College Observatory refers chiefly to the valuable services rendered by the director in promoting co-operation among astronomers. It is now about forty years since Prof. Pickering began to advocate the advantages of united efforts in carrying out some of the larger investigations in astronomy, and at the present time a considerable amount of the work of the

Harvard Observatory is carried on in co-operation with other institutions. Prof. Pickering has also assisted largely in the organisation of amateur astronomers in America, especially for the observation of variable stars, in which thirty observers are now associated. For this work the observatory has furnished suitable charts, and determinations of the magnitudes of nearly 5000 reference stars.

Harvard Circulars Nos. 203 and 204 have also been received. The first includes particulars of asteroids which will attain magnitude 10, or brighter, during 1918, and the second contains a valuable summary of the observed magnitudes of Nova Persei No. 2 from 1902 to the end of last year, together with a list of comparison stars suitable for future determinations.

THE CANADIAN "OBSERVER'S HANDBOOK."—A useful service to its members is rendered by the Royal Astronomical Society of Canada in the annual publication of "The Observer's Handbook." It includes a collection of astronomical data, referring especially to the sun, moon, and planets, arranged very conveniently in the form of a calendar. There is also a special list of occultations, calculated for Ottawa. Tables which vary but little from year to year have been omitted from the present issue.

EPHEMERIDES OF ALGOL VARIABLES.—In the *Journal des Observateurs*, vol. ii., No. 4, M. Luizet has given a valuable series of tables, from which observers can readily prepare a list of the dates of occurrence during the present year of minima of 123 variables of the Algol type. The epoch of the first minimum occurring in each month is given in the first table, and the length of period, and multiples thereof, in the second. The variables are designated by the notation of André, as well as by that of Argelander.

THE TRAINING OF THE FRENCH ENGINEER.

IN the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* for September-October last appears a valuable report of the proceedings of the Society of Civil Engineers of France concerning the training of engineers of the first rank, alike for the special services of the State and for leading positions in industry. Not only is the specialised training required considered in the article, but also the previous preparatory education. The matter arose on the presentation of an important communication from M. Léon Guillet, a member of the society, which was considered at a special session of the society held on November 3, 1916, at which the Minister of Commerce and Industry presided. The communication embraced a comparative study of the subject of technical training as it is pursued in France and abroad, a thoughtful criticism of the existing means and methods of such instruction and the preparation required for it, and an expression of personal views as to the lines upon which in future both preparatory and technical studies should proceed. A special commission was appointed, which sat during five sessions, extending to the end of April, 1917, and took important evidence from professional and other persons engaged in engineering.

An official invitation was received by the society in January, 1917, from the Minister of Commerce and Industry, to formulate proposals for the essential modifications required, in its opinion, to be introduced to ensure the more efficient education and training of professional engineers. These proposals take the form of recommendations relative to reforms in the aims and methods of secondary education, as a preparation for higher technical schools, in which it is suggested that the classical studies should be lessened, the teaching of modern languages encouraged, and courses in manual exercises introduced. It is also suggested that the plan of instruction should be arranged so as to meet the needs on one hand of those proceeding to higher normal schools, and on the other of those entering the technical high schools.

Great importance is attached to the necessity for the fullest opportunity of laboratory practice in the technical high schools, and for the encouragement not only of a spirit of individual research and inquiry in the students, but also of a more intimate relation between them and the teaching body with less merely *ex cathedra* teaching. It is laid down as essential that the directing and teaching *personnel* of the engineering schools shall be recruited from persons actively associated with industrial conditions, and that the students themselves shall have had the opportunity of work in the factories and of travel-study in the workshops of France and in foreign countries. The vital importance of the economic aspect of industry is insisted upon, and with the view of increasing French influence abroad, every encouragement should be given to foreigners to follow in whole or in part the instruction in the technical high schools, and, finally, it is recommended that so far as possible the native pupils shall be admitted without fee, and assisted, where necessary, by loans without interest. It is suggested that regular military training shall be maintained in these schools, that the time spent in them shall count as two years in the Service, and that the one year of effective service shall consist of six months with the colours and six months in the service of the State or in industries susceptible of contributing to the national defence, or in camp instruction for officers.

Proposals are made for further specialised and advanced instruction of a post-graduate character, and after the manner of the newly founded High School of Electricity, it is suggested that institutions dealing respectively with machinery and iron and steel construction, metallurgy, chemistry, textiles, public works and railways, and naval construction should be established, and short technical courses of a very advanced character dealing with the most recent progress in technical science offered to professional engineers engaged in works. The proposals are further elaborated in a long communication from the vice-president of the society to the Minister of Commerce and Industry which is well worthy of the attention of the engineering profession in this country.

NEMATODES AND PESTS.

PROF. WARRINGTON YORKE and Dr. B. Blacklock (in Annals of Trop. Med. and Parasitology, vol. xi., No. 2, 1917) have recorded a series of interesting observations on the periodicity of the larvæ of the nematode worm, *Filaria bancrofti* (*nocturna*), in an Australian who contracted the infection in Queensland. It is well known that during the night the larvæ of this species are concentrated in the cutaneous vessels, while during the day they are present there in small numbers only. The authors estimated the number of larvæ in the cutaneous blood every two hours for a period of twenty-four hours on December 21–22, 1916, and again on January 5–6, 1917. The maximum concentration observed was at midnight, when there were 12,850 larvæ per cubic centimetre. Although the number of larvæ fell to a low level during the daytime they were never absent, the minimum number noted being 50 per c.c. of cutaneous blood. A discussion of the ob-

servations has led the authors to the conclusion that the nocturnal periodicity of the larvæ is primarily dependent upon periodic variations in the arterial supply of larvæ to the cutaneous vessels. The periods of sleep and activity of the patient were reversed, and there resulted a gradual change in regard to the period of the cutaneous immigration of the larvæ. After four days the maximum concentration of the larvæ in the cutaneous vessels had been changed from midnight to 6 a.m., and after eleven days to midday. Graphs showing the number of larvæ per c.c. of blood passed in the urine reveal the existence of a regular periodicity corresponding with that of the larvæ in the cutaneous blood, with the difference that the time of maximum concentration of larvæ in the renal and vesical vessels was several hours later. Messrs. Malins Smith and Matthews give, in the same number of the Annals, further records of the occurrence of intestinal protozoa in non-dysenteric cases. Their results show that among the 200 returned soldiers examined in Liverpool *Entamoeba histolytica* was present in twelve of the 158 cases, with no previous history of dysentery.

Dr. N. A. Cobb, of the United States Department of Agriculture, has published (in *Nematology*, vol. iii., pp. 431–86) an account of the nematode genus Mononchus. The genus is of world-wide distribution, and some of the species are cosmopolitan. Mononchs are regularly present in arable land of a sandy or loamy nature, and sometimes occur in great numbers; the author estimates that there were at least thirty millions per acre in the top six inches of a field of maize in New Jersey. Most mononchs are carnivorous; they have been found to feed on protozoa, on rotifers, and on other nematodes. One cosmopolitan species was found by the author in Florida feeding on the larvæ of *Heterodera radicicola*, a serious root-pest, and it is suggested that further investigations may reveal the possibility of utilising mononchs to reduce the enormous losses in crops due to plant-infesting nematodes. A description of the characters and anatomy of the genus is given, and it is stated that the females of many, probably of most, species are really hermaphrodite, the gonad producing also spermatozoa, which are so minute that they have apparently hitherto escaped notice. Males, if found at all, are nearly always rare, and of most of the species males are not known. A key is provided to the subgenera and to the fifty-seven species—including twenty-eight described as new in this memoir—and the text has seventy-five excellent figures.

RAINFALL DISTRIBUTION OVER FRANCE.[1]

THIS is the first portion of a contemplated large investigation into the rainfall distribution over France, and deals with the *régime* over the North-West Provinces. Other memoirs will contain a discussion of the data for the south-west, north-east, and south-east of the country for the fifty years 1851–1900. In the work under notice, which is an extract from the memoirs of the French Central Meteorological Office, full particulars are given of the data used in compiling the maps of average rainfall based on a fifty years' normal, by a comparison of short-period data with standard stations, affording records for the complete series. In some cases the standard stations seem to be at a considerable distance from the short-period record to be corrected to the fifty years' normal.

The variability of rainfall based on records for sixteen stations in France and adjacent countries during the second half of last century is discussed, from which it is shown that the departures of individual years from the normal are in accordance with the theory of probabilities. A list of the stations arranged in river basins is given by departments, along with the altitude and the period of observation. Monthly isohyetals are drawn at intervals of 10 mm. up to 100 mm., but at 120 mm. and 150 mm. thereafter, while on the annual maps the intervals extend to 100 mm. A summary of the leading features governing the rainfall distribution is given for each month and for the year.

In almost all the regions considered October is the wettest month, the rainfall exceeding 100 mm. in the country of Caux, the department of the Manche, the western part of Brittany, and the heights of Gâtine, the maximum being 151 mm. at Saussemesnil; while the driest areas in this month are the middle valley of the Seine, the basin of the Eure, and on the Beauce, where the rainfall is between 50 mm. and 60 mm., but not under the former value. The driest month is February, not only as regards the actual quantity, but also taking into consideration the shortness of the month.

For the whole year the driest regions are the basins of the Seine, the Loire, and the Oise, where the precipitation varies between 500 mm. and 600 mm. The stations where more than one metre of rain falls are extremely few, and are mostly located in mountainous areas, the maximum being 1181 mm. in the Monts d'Arrée. No detailed description appears of the methods of mapping the material utilised. Rivers are shown, but towns, railways, and departments are not indicated, nor are the orographical features shown. The maps clearly indicate the very patchy distribution of rainfall, and have evidently been drawn with much care. The originals were on a scale of 1 : 1,500,000, or twenty-two miles to an inch, and then reduced for publication on a scale of thirty-nine miles to an inch.

MINERAL PRODUCTION OF PERU AND THE PHILIPPINE ISLANDS.

THE official report upon the mineral production of the Philippine Islands for the year 1915 has recently been issued by the Division of Mines, Bureau of Science, of the Government of the Philippine Islands. The importance of the gold production far outweighs that of any other mineral; its value is returned as 2,633,528 pesos, say about 274,000*l*., being an increase of 12·1 per cent. above that of 1914. The gold bullion, of course, also carries a certain amount of silver, which is valued separately. The only other metallic product is iron, of which ninety-six tons appear to have been produced, this being only about one-half of the production of the previous year. This iron is all produced in small native furnaces, and is worked up into ploughshares or similar articles; the main reason in the falling off is the competition of inferior articles, made from scrap-iron. There is no production of native coal, none having been worked since 1912. The other minerals, of which returns are included, are salt, sand and gravel, clay products, stone, lime, and mineral waters. The total value of all these is estimated at rather less than the value of the gold output.

The mineral statistics of Peru for the year 1915 show a considerable increase in most of the products according to the report (No. 83) recently published in Lima. The total value is given as 5,930,000*l*., being an increase of 42 per cent. above that of 1914. This increase is due in part to the important rise in the value of mineral products, but it must be noted that this rise did not extend to the value of silver, and as

[1] "Etudes sur le Climat de la France. Régime des Pluies. Première Partie. Considérations géné-rales: Région du nord-ouest." Par M. Alfred Angot. Pp. 128+13 plates.

silver ranks high amongst the mineral productions of Peru, the increase is less marked than it would otherwise have been. The leading products are copper, 34,727 metric tons; petroleum, 363,162 metric tons; silver, 294,425 kilos.; vanadium ore, 3145 metric tons; gold, 1690 kilos; coal, 290,743 metric tons. These are the only minerals the annual value of which exceeds 200,000*l.*; all the others are far less important. The production of copper, already very important, appears to be likely to increase still further. It is also noteworthy that of the total export of copper no less than 93·85 per cent. was in the form of bars, so that practically the whole of the copper ores produced in Peru are now smelted in that country. This effect is largely due to the heavy rise in freights; before the war these were about 30*s.* to 2*l.* per ton, whereas in 1915 they rose to 5*l.* to 6*l.* per ton without taking the increased cost of insurance into account, so that for any ore or matte containing under 40 per cent. of copper the rise in freights would outweigh a rise of 10*l.* in the price of the metal. This effect would be even more marked in the case of ores of a cheaper metal like lead, so that nowadays Peru exports few ores except those of such metals as vanadium, tungsten, molybdenum, etc., which, on account of their considerable intrinsic value, are proportionately less affected by a rise in freights. It is worth noting that the production of coal has only increased from 283,860 tons in 1914 to 290,743 tons in 1915, whilst the imports have fallen from 139,312 tons to 55,662 tons, in spite of the increased development of the metallurgical industry, as just pointed out, the reason being that the use of petroleum to replace coal as a fuel is on the increase, the output of oil having risen 43·7 per cent. above that in 1914.

NATIONAL LABORATORIES AND INDUSTRIAL DEVELOPMENT.[1]

II.

A National Proving House and Standardising Laboratory.

CERTAIN general principles seem to me essential to success, namely:—

(1) Standardisation and testing must, if they are to be of value, depend upon research, and be closely connected with it.

(2) While there must be the closest union between the testing authority and the trade concerned with the production of the goods to be certified, the authority should not be dependent on the trade for financial support, and while the wishes of the trade as to the standards to be attained must be fully considered, the executive of the testing institution should be an independent authority.

Testing must go hand in hand with research. For, in the first place, research is necessary in order to set up the standards required. Take, for example, our standards of length. The yard or the metre is the distance between two marks on certain standard bars very carefully preserved. They are both arbitrary standards, it is true, and it is clearly of the greatest importance that they should be invariable. Do we know that this condition is secured, and, if so, how do we know it? Materials certainly alter their dimensions with changing temperatures, and possibly also with time; for standard work we must know the temperature at which we make our comparisons, and this need leads at once to the investigation of the methods of measuring temperature and of the amounts by which various materials change in size with changes of temperature. A wide field of investigation opens directly; temperatures are measured by thermometers. How are the various kinds of thermometer connected? Do a mercury thermometer and a gas thermometer give the same results? Is the glass of which an ordinary mercury thermometer is made of importance? Or, again: To what extent is the length of a yard measure of brass or steel dependent on the temperature? Can we find a material less sensitive to temperature changes than the platinum-iridium alloy of which the standard metre is made? And so on. The investigations necessary before we can standardise our yard measure have called for much research. But, again, what security have we that even if we keep the standard with the greatest care and make our comparisons under the most favourable conditions of temperature, its length is invariable? Is the metre the same length now as when it was first deposited at the Bureau des Poids et Mesures at Sèvres? To answer this question a research of great difficulty was carried out at Sèvres by Michelson when he compared the length of the metre with the wave-length of light under certain specified conditions. There are cogent reasons for supposing that to be an invariable quantity.

At the laboratory during the past two years we have tested vast numbers of gauges and the improvement in manufacture has been very marked; this has been reached only by careful investigation into each cause of error by attention to small details, and by research into methods of measurement with a view to their simplification so that they could be used in the workshop, and to improvement in accuracy so that the results obtained were not vitiated by errors in the method of obtaining them.

A visit to the gauge-testing-room of the National Physical Laboratory will show anyone how closely research and standardisation go together, how hopeless it would be to try to run a standardising laboratory apart from research. Or, again, to take an example from another department of science. Ohms and volts and amperes are nowadays familiar words; you measure the one with a Wheatstone bridge, or more probably with an ohmeter, you read off the others in a voltmeter or an ammeter. But the definitions of these quantities are highly technical and scientific.

Do you realise what research has been required before our present practical system of making electrical measurements was evolved, and how much you owe to that research? Compare the rate of advance of the electric motor and the steam engine.

The work of the Engineering Standards Committee has been of untold advantage to the country. At every step of that work the committee has kept in close touch with scientific principles, and researches of the most varied character have been carried out, and are being carried out now, with the view of determining what standards to set up and what tests to prescribe.

Nor is it enough to say that much of this has been done and need not be carried further; the principles on which ammeters and voltmeters are made have been thoroughly investigated, the optical laws with which telescopes and lenses must comply are well known; lay down your tests and specifications, and train observers, analysts, and testers to enforce them, and you have done all.

Stagnation and death, not life and progress, lie that way. It is not our object merely to apply with rigid fairness the laws laid down, and to be pleased rather than otherwise, like the mythical examiner, when we "plough" them every one. The standards set must be reasonable, but they must tend to raise the quality of the product tested. Recurring defects must be watched and investigated, and the tests modified to prevent

[1] Abridged from two lectures delivered at the Royal Institution on February 26 and March 5 by Sir R. T. Glazebrook, C.B., F.R.S. Continued from p. 77.

them; you must gain the confidence of the manufacturer and lead him to realise you are out to help him, and that you really know something, probably more than he does, of the strength and weakness of his goods. Nearly all Englishmen are anxious to maintain the reputation of their country, and welcome fair tests which show up bad work and make for its improvement. Our statistics show the improvement that is produced by tests properly carried out.

So much, then, for my first contention, that research and standardisation must go hand in hand; the truth of the second, that the testing authority should be independent of the manufacturer, is, I think, obvious. It is necessary to give confidence.

A certificate has but little value, even if it states the truth and nothing but the truth, unless it comes from an absolutely impartial source. If I bear witness of myself, my witness is nothing. To the old customers of a well-established firm the assurance of the firm is sufficient; a stranger looks for some independent evidence before he accepts as true all the claims made by the man who desires to sell his latest production as something far superior to all else on the market.

Impartiality is the first attribute of justice, and the suspicion that the judge may be swayed by something besides the strict merits of the case is fatal. Again, it is necessary for the good of the manufacturer. False praise is dangerous to the recipient. The man who relies on the verdict of a too friendly critic may easily fail to maintain the high quality of his products and find himself outstripped by one who has been spurred to effort by fair and judicious criticism.

A testing laboratory controlled by an association of manufacturers for the advancement of their trade is of much less value, both to them and to the country, than one in which the ultimate decisions rest with an independent authority. Of course, the standards to be worked to must be determined in closest co-operation with the trade. No specification is ever adopted by the Engineering Standards Committee until it has been fully discussed at meetings at which the trade is fully represented; in no case is the decision as to whether an article comes up to the standard left to such a meeting, and this has had an important bearing on its success. At the laboratory we have advisory committees on various matters. Executive powers rest with the Executive Committee or with the director acting under the instructions of that committee. He signs all the certificates, and is responsible only to the committee, and this seems to me the proper plan.

[The lecturer then proceeded to describe and illustrate on the screen some of the principal tests now carried out at the laboratory.]

Having now dealt with the test work at the laboratory, and the method of procedure, let us turn to the future. Is the work of value? If so, what steps have been taken to make it of more value still, to increase its range, and to widen its influence? Are further steps desirable, and, if so, what should they be?

Its value is, I think, recognised; the recent growth in many branches of our work, besides that of testing gauges for engineers, is evidence of this; the proposals to establish standardising laboratories in various centres of industry point in the same direction. Engineers are coming to recognise more and more the importance of interchangeability, the advantage of working to limits, the gain in producing power—combined, I fear, with deadly dullness in much of the work—secured by the standardisation of parts.

Here, I think, a word of caution is necessary. Local standardising institutions are desirable in certain cases; local standards are most undesirable. I am not sure how many wire gauges used in the sale and purchase of wire and thin metal sheets there are. In a recent list I saw enumerated some six or eight, each with its own tolerances, or in many cases with no tolerances at all; each has been introduced to fill a need, but with no thought for other needs. There is a risk, I fear, that the establishment of local testing laboratories, unless care is taken to connect them with some central institution responsible for maintaining their standards and co-ordinating their methods, may tend to perpetuate like anomalies. There is already, as many of us know, a standard inch and an "Enfield" inch; we do not want Manchester, Leeds, and Birmingham inches.

Transit is easy, and the delay involved in sending goods to a central institution need not be great; the uniformity of results secured in this manner is worth much. Where this cannot be done there should be some organisation devised to keep the standards employed in all parts of the country alike within agreed limits, and to maintain this connection with the results of research.

The increase in the number of clinical thermometers has already been mentioned. Tests on optical instruments of all kinds are growing, and steps have been taken to add to the staff and improve the facilities for handling these.

The quantity of glassware used in chemical laboratories throughout the country is enormous. In pre-war days this was almost all of German manufacture, and much came into the country with Reichsanstalt certificates. English manufacturers have taken up the question, and are now prepared to offer large supplies, and a scheme has been arranged for its standardisation and the issue of certificates. This is the outcome of discussions of a committee on which were representatives of the Department, the manufacturers, the users, and the laboratory. The limits of error for the various classes of articles have been provisionally fixed, and a schedule of fees settled which the makers think reasonable, and it is hoped will in time enable the work to be carried on without loss. For the present a house has been secured at Teddington, and is being equipped, in which the testing can for the time go on—a certain amount of this class of work has always been carried out at the laboratory. Additional buildings are to be erected, and the scheme put on a permanent footing.

The quantity of the various articles is very large, and it is not necessary that all should be tested to the same limits of accuracy, nor would it be possible to send them all to the laboratory. This difficulty will be met by having two classes of goods treated differently. For work of the highest accuracy it is necessary that the articles should be sent to Teddington and be tested individually. Those that pass the tests will constitute Class A, and receive the laboratory mark. The vast majority will be dealt with at local centres organised by the laboratory and manned, at least so far as the more responsible positions go, by members of the laboratory staff. These centres will, in some cases, be at the large works; in others it is hoped to interest the local universities or technical colleges. At the head of each will be the N.P.L. inspector, who will be free to visit the works, inspect the methods of manufacture, and select for test from each batch such articles as he thinks fit. So long as the methods remain satisfactory and the goods come up to standard, the firm will be licensed to mark the articles in some distinctive way.

A fee will be charged for each article tested at the laboratory. In the case of the articles inspected or tested in bulk, it is proposed to cover expenses by a royalty reckoned on the numbers produced, which would be charged for permission to use the trade-mark.

Such a scheme, it is clear, requires the cordial co-operation of the makers and the inspecting authority.

This we have already been promised, and while the conditions of test and the limits permissible are settled after consultation with the manufacturers, the enforcement of those conditions and the power to refuse the licence rest with an independent body. Such a plan, it seems to me, is far preferable to the alternative under which an association of the manufacturers would run its own testing laboratory.

A similar scheme is clearly applicable to other industries. For engineering work the standards of the Engineering Standards Committee are mostly adopted. The laboratory holds the standard screw gauges of the committee as well as the rail templates and other similar standards. Some organisation whereby standards employed locally for testing purposes are controlled by the laboratory and kept in close correspondence with those at Teddington ought not to be difficult to devise, and would secure much of what is needed, though with screw gauges at present identity of the method of testing rather than of the standard of comparison is what is difficult to secure.

Or, again, with electrical instruments, supply meters, ammeters, voltmeters, and the like can be, and are, sent to the laboratory, and where high accuracy is required this must be done. Very large sums depend now on the measurement of the energy supplied from central stations to big works, tramway systems, collieries, and other large installations, and very high accuracy is needed. This, too, is true in the case of acceptance tests of large machinery. The necessary accuracy can be obtained only in a properly equipped laboratory, and, indeed, in the case of meters, an individual test is always necessary, but where the type has been tested and approved the individual tests could be carried out by inspectors at the works, or at some convenient local institution. And there are many pieces of apparatus and small plant which could be dealt with in a similar manner to the chemical glassware.

The Engineering Standards Committee has specified the performance tests for motors and dynamos requisite before the term "British standard" can be applied to them. It is clearly impossible to expect that every small motor should have been put through these tests. It would be quite simple to arrange that some limited number of the type were tested out at the National Physical Laboratory, that steps were taken, by inspection and occasional tests, to secure that in subsequent production the same standard was attained; and, so long as this was done, to license the manufacturer to put the E.S.C. mark on his machine, and call it a "British standard machine."

The process can be extended to other electrical products; it has already been suggested for lamps, and four years ago I had good hopes that some action of the kind would be taken—1914 stopped it for the time. I would urge that now is the time to develop a scheme of the kind so that we may be ready when once more peace reigns on earth among men of good will.

The scheme is a large one, one that as director I cannot hope to see fully developed. It is enough perhaps for me to have indicated how the laboratory may grow, both as a National Research Laboratory and as a National Proving House and Standardising Laboratory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS PHYLLIS M. BORTHWICK, lecturer in physics at the Ladies' College, Cheltenham, has been appointed assistant-professor of physics and chemistry at the Lady Hardinge Medical College for Women, Delhi.

ON the first Saturday of each month from May to October, at 3.30 p.m., free public demonstrations on practical bee-keeping will be given in the Horniman Gardens or the Museum, Forest Hill, S.E., by Mr. W. H. Prior, of the Kent and British Bee-keepers' Associations.

M. PAUL OTLET'S article in the *Revue générale des Sciences* for February last on "The Future of the International Catalogue of Scientific Literature" contains a short account of the foundation of the catalogue and some proposals for its future development. The vast experience which M. Otlet has acquired at the International Institute of Bibliography at Brussels entitles his opinion on such a subject to respect. It is, however, difficult to reconcile his statement that "before the war the German Government had decided to withdraw from the International Catalogue" with the fact that at the meeting of the International Council of the catalogue held in London on June 11 and 12, 1914, about six weeks before the war broke out, the representative of the German Government, Dr. Uhlworm, proposed the resolution:—"That the International Catalogue of Scientific Literature shall be continued during the years 1916–20," which was adopted by the council. M. Otlet would like to see the International Catalogue extended to include technology, industrial sciences, medicine, agriculture, social sciences, philology, literature, the fine arts, history, geography, philosophy, and religion. In view of such extension he thinks the work of the regional bureaux in the various co-operating countries should no longer be controlled by scientific societies, but undertaken by the authorities of the National Library in each country. M. Otlet suggests that in view of the continual increase in the number of scientific journals, authors should agree not to publish original papers in any periodical that was not included in a list drawn up by mutual agreement. In order that subscribers to the catalogue may be in possession of the latest information, M. Otlet recommends that the index-cards received at the Central Bureau should be printed and issued at once. As each volume appeared, the cards corresponding with that volume would be destroyed by the subscribers, who need keep only such cards as had not yet been published in a volume.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 21.—Sir J. J. Thomson, president, in the chair.—Dr. C. **Chree**: The magnetic storm of December 16–17, 1917, as recorded at Kew and Eskdalemuir Observatories. The magnetic storm of December 16–17, 1917, was of very considerable though not outstanding magnitude. It commenced between 8h. and 9h. on December 16, and had not wholly subsided before the afternoon of the following day. Attention is directed in the paper to the curves for the twenty-four hours commencing at 8h. on December 16. The most active period of disturbance was between 15h. (3 p.m.) on December 16 and 4h. on December 17. A prominent feature in the curves was a succession of oscillations of periods averaging about twenty minutes. There were also, especially at Eskdalemuir, some very large short-period oscillations. The paper compares the oscillations recorded at the two observatories, and gives estimates of the rate of change of the magnetic elements during the most rapid movements. The amplitude and rapidity of the changes proved to be much greater at the more northern station.—E. A. **Owen**: The absorption of X-rays. (1) The absorption coefficients of a number of substances for a radiation of wave-length $0{\cdot}586 \times 10^{-8}$ cm. (the α-line of palladium) have been determined, and the values

obtained confirm those of Bragg and Pierce in the case of elements used in common. (2) The atomic fluorescent absorption coefficient is proportional approximately to the fourth power of the atomic number of the absorber. (3) The following relation exists between the atomic fluorescent absorption coefficient, atomic number of the absorber, and the wave-length of the radiation absorbed, $fa = CN^4\lambda^3$, where C is a constant over certain ranges, but changes abruptly at critical points. This relation is independent of the scattering coefficient; it refers only to the loss of energy of X-radiation by the production of corpuscular radiations and the fluorescent X-radiations that accompany them. (4) Calculations based on the above general relation show that the molecular total absorption coefficients of different substances observed by Auren with radiation of wave-length $0{\cdot}35 \times 10^{-8}$ cm. may be deduced very approximately from the atomic total absorption coefficients obtained for different elements with radiation of wave-length $0{\cdot}586 \times 10^{-8}$ cm. if the coefficient of scattering be assumed to have a constant value of 0·2 for all elements from hydrogen to bromide for both these radiations.

Linnean Society, March 21.—Sir David Prain, president, in the chair.—Miss B. Muriel **Bristol**: A Malayan form of *Chlorococcum humicola* (Naeg.), Rabenh. Cultures were made in October, 1915, from about sixty specimens of soil, the observations now reported being obtained from Kajang, near Kuala Lumpor, Malay States, after about two years in a closed specimen-tube; the soil was placed in a mineral-salt solution and allowed to remain under the room-temperature. In June, 1916, growth of the soil-alga began, and its life-history is now set out, tracing it from the vegetative cells, which are solitary or congregated into globular clusters. Later, multiplication by zoogonidia was observed, with their fusion forming zygotes, also by aplanospores, but true vegetative division does not take place. The same alga was found in soil-cultures from English localities, in some cases of considerable age. Thus a sample from Rothamsted Experimental Station taken in 1856 yielded the alga, but a sample taken in 1846 did not, so that presumably a period of seventy years marks the extreme limit of revival.

Zoological Society, March 19.—Dr. A. Smith Woodward, vice-president, in the chair.—Miss Maude L. W. **Cleghorn**: First report on the inheritance of visible and invisible characters in silkworms.

Mineralogical Society, March 19.—Mr. W. Barlow, president, in the chair.—Prof. E. S. **Federov**: Graphical operations with four independent variables. *A propos* of Boeke's suggestion of the use of multi-dimensional geometry for such operations, with special reference to the case of the chemical constitution of tourmaline, the author remarks that he had already put forward a similar suggestion, without, however, making use of imaginary dimensions. A system of points is replaced by a system of vectors, and in this way, since each end of a vector has two co-ordinates, a relation between four independent variables may be expressed graphically. Different series of vectors of the first order give rise to vectors of the second order, and they in their turn to vectors of the third order. Certain special cases were discussed.—Prof. R. P. D. **Graham**: Lattice-like inclusions in calcite from North Burgess, Ontario. The calcite, which is almost invariably twinned about $e(01\bar{1}2)$, contains numerous fine needles, arranged parallel to the edges of the rhombohedron *e*, of a hydrous magnesium silicate, which chemical analysis showed to correspond with the formula $5MgO.6SiO_2.4H_2O$, which is usually assigned to the mineral spadaite. Since the needles are only slightly acted on by cold dilute acid, they remain behind in the form of a lattice on dissolution of the calcite. Other included minerals are pyroxene, quartz, titanite, and pyrites. The source of the solutions which supplied the magnesium silicate was discussed.—Dr. J. W. **Evans**: Linear rock-diagrams. The different types of linear or variation diagrams, in which the chemical constituents of different rocks are represented by vertical distances, were reviewed, and the use of modifications to indicate the probable mineral compositions was proposed. Each rock is represented by two diagrams. In the first or alumina diagram, distances representing the molecular proportions of (1) the potash, (2) the potash and soda, and (3) the potash, soda, and lime in each rock are measured vertically upwards from the base line, and corresponding points for different rocks are connected by continuous lines. At the same time distances representing (4) the alumina, (5) the iron oxide, and (6) the magnesia are measured on the same lines in the same manner, and are connected by continuous lines. Not only will this diagram indicate the proportions of the constituents, but also the position of the points on line (4) relative to those on lines (2) and (3) will indicate the probability of the occurrence of minerals dependent on the amount of alumina. If (4) is higher than (3), andalusite, cordierite, or mica may be expected, as well as hypersthene, all the lime being converted into anorthite. If (4) is less than (3), diopside, augite, or the corresponding amphiboles will probably be present, and, if it is less than (2), minerals of the ægirine type may be found. In the second, or silica, diagrams the lowest series of points shows the amount of silica required by the bases of a rock for the formation of leucite, nepheline, anorthite, wollastonite, and olivine, the second series the additional silica necessary to form orthoclase and albite, and the third series the amount required to convert the olivine into hypersthene, while the fourth line represents the amount of silica actually present. The position of the last relative to the others will throw valuable light on the silicates that may be expected, though allowance must be made for the influence of the bases on one another. For instance, the presence of the constituents of wollastonite will call for a higher silicification of part of the olivine to form a monoclinic pyroxene or amphibole at the expense of the felspars.

MANCHESTER.

Literary and Philosophical Society, March 19.—Mr. W. Thomson, president, in the chair.—Prof. G. Elliot **Smith**: Race, character, and nationality. The influences of race and heredity, geographical circumstances, and language, though potent in various directions to affect the character and achievements of individuals and to play a part in the development of the true spirit of nationality in a community, are not the chief factors. The personal experience of each individual, his social environment, and especially the traditions of his community, shape his outlook on life, determine his character, and give specific directions to his inherited aptitudes. The most powerful forces that mould nationality and weld together a heterogeneous collection of people of varied origin, abilities, and traditions consist of historical circumstances which provide the community with common aims and aspirations, common traditions and social fashions, common trends of thought and modes of behaviour. Such circumstances play a more vital part than mere race or hereditary aptitudes in the development of the spirit of nationality.

PARIS.

Academy of Sciences, March 18.—M. Paul Painlevé in the chair.—The president announced the death of Lord Brassey, correspondant of the Academy for the section of geography and navigation.—P. **Termier**: Contribu-

tion to the knowledge of the tectonics of the Asturias: anomalies at the contact of the Coal Measures and the Arnao Devonian.—P. A. **Dangeard**: The nature of the chondriome and its *rôle* in the cell. Current views on the nature and function of the chondriome are questioned, and new facts based on a method of staining with cresyl-blue are given. This stain can be applied in such a manner that there is no interference with the life of the cell. It is shown that, contrary to the generally accepted view, the chondriome of the cell is altogether independent of the plastidome.—E. **Ariès**: A formula giving the saturated vapour pressure of a diatomic liquid. An extension of the method described in previous communications for monatomic liquids. Chlorine and carbon monoxide are worked out as examples.—M. G. Kœnigs was elected a member of the section of mechanics in succession to the late M. H. Léauté.—M. T. **Beritch**: The convergence and divergence of series with real positive terms.—A. **Buhl**: The intervention of the geometry of masses in certain theorems concerning algebraic surfaces.—L. **Schlussel**: The measurement of rapid and irregularly variable dynamical actions.—B. de **Fontviolant**: New theory relating to the effects of the wind on bridges.—D. **Eydoux**: The movements of water in equilibrium pipes.—A. B. P. **Leme**: A new method of quantitative analysis. Suggestion for a new arrangement of spectrograph for quantitative work.—A. **Mailhe** and F. de **Godon**: A new method of preparation of monomethylaniline and dimethylaniline by catalysis. A mixture of the vapours of methyl alcohol and aniline is passed over alumina at a temperature between 400° and 430° C., when a mixture of monomethylaniline and dimethylaniline is obtained, containing only traces of aniline. By a repetition of the process with addition of methyl alcohol, dimethylaniline is obtained. The new method has the following advantages over the process in current use: the aniline may contain water and the methyl alcohol need not be specially purified from acetone; also, the use of autoclaves and high pressures is unnecessary.—E. **Léger**: The action of hydriodic acid upon cinchonine and on its isomers, cinchonigine, cinchoniline, and apocinchonine.—L. **Gentil**, M. **Lugeon**, and L. **Joleaud**: The existence of a Triassic sheet in the Sebou basin, Morocco.

BOOKS RECEIVED.

Medical Electricity. By Dr. L. Jones. Seventh edition, revised and edited by Dr. L. W. Bathurst. Pp. xv+588. (London: H. K. Lewis and Co., Ltd.) 15*s*. net.

The Nature of Solution. By H. C. Jones. With a Biographical Sketch by Prof. J. E. Reid, and Tributes by Profs. Arrhenius, Ostwald, and Woodward. Pp. xxiii+380. (London: Constable and Co., Ltd.) Price 12*s*. 6*d*. net.

The Megalithic Culture of Indonesia. By W. J. Perry. Pp. xiii+198. (Manchester: At the University Press; London: Longmans, Green, and Co.) Price 12*s*. 6*d*. net.

Aeronautics in Theory and Experiment. By W. L. Cowley and H. Levy. Pp. xi+284. (London: E. Arnold.) Price 16*s*. net.

Essays in Scientific Synthesis. By Eugenio Rignano. Pp. 254. (London: G. Allen and Unwin, Ltd.) Price 7*s*. 6*d*. net.

Lecithin and Allied Substances: The Lipins. By Dr. H. Maclean. Pp. vii+206. (London: Longmans, Green, and Co.) Price 7*s*. 6*d*. net.

Thirty-first Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1909–10. Pp. 1037. (Washington: Government Printing Office.)

DIARY OF SOCIETIES.

MONDAY, APRIL 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Future of the Albanian State: Capt. J. S. Barnes, R.F.C. (leave permitting).

ARISTOTELIAN SOCIETY, at 8.—Value and Existence: Dr. F. C. S. Schiller

TUESDAY, APRIL 9.

ROYAL INSTITUTION, at 3.—Scientific Signalling and Safety at Sea: Prof. J. Joly.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Derwent Valley Water works: E. Sandeman.

ZOOLOGICAL SOCIETY, at 5.30.—Head of the Charasinid Fish, *Hydrocyon goliath*: Dr. G. A. Boulenger.—The Variation of the Pit-Viper, *Lachesis atrox*: Miss J. B. Procter.

RÖNTGEN SOCIETY, at 8.—The Silvanus Thompson Memorial Lecture: Sir Ernest Rutherford

WEDNESDAY, APRIL 10.

ROYAL INSTITUTION, at 3.—Scientific Signalling and Safety at Sea: Prof. J. Joly.

BRITISH ASSOCIATION GEOPHYSICAL COMMITTEE (Royal Astronomical Society), at 5.—Earthquake Waves: Prof. H. H. Turner and Dr. G. W. Walker.—Earthquake Frequency: R. D. Oldham.

THURSDAY, APRIL 11.

ROYAL INSTITUTION, at 3.—Experimental Psychology: Lt.-Col. C. S. Myers.

INSTITUTION OF ELECTRICAL ENGINEERS (Cancer Hospital, Fulham Road), at 6.—Joint Meeting with the Electrical Section of the Royal Society of Medicine.—Papers on Medical Electricity.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—Presidential Address: Hugh F. Marriott.

OPTICAL SOCIETY (Imperial College of Science and Technology, South Kensington), at 8.—The Balsam Problem: J. W. French.

FRIDAY, APRIL 12.

ROYAL INSTITUTION, at 5.30.—Absorption and Phosphorescence: Prof. E. C. C. Baly.

ROYAL ASTRONOMICAL SOCIETY, at 5.

SATURDAY, APRIL 13.

ROYAL INSTITUTION, at 3.—Musical Instruments Scientifically Considered: Prof. E. H. Barton.

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