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DIFFERENTIAL EQUATIONS.

A Treatise on Differential Equations. By Prof. A. R. Forsyth, Sc.D., LL.D., Math.D., F.R.S. Pp. xvi + 511. Third Edition. (London: Macmillan and Co., Ltd., 1903.) Price 14*s*.

THE value of this useful text-book has been increased by the inclusion in the third edition of important additional matter.

The principal additions are an account of Runge's method for the approximate numerical solution of ordinary differential equations, of Frobenius's method for the integration of linear equations in series, and of Jacobi's theory of multipliers.

The chief modifications of the matter treated in the earlier editions occur in the treatment of Lagrange's linear partial differential equation of the first order, in the discussion of the condition of integrability of a total differential equation, and in the treatment of Riccati's equation.

Of the above-mentioned subjects the one of greatest theoretic interest is probably the treatment of Lagrange's equation, whilst the most useful is Frobenius's method of integrating linear equations in series.

The theoretic interest of the treatment of Lagrange's equation arises from the fact that until Goursat published his "Leçons sur l'Intégration des Équations aux dérivées partielles du premier ordre" in 1891, the widely used rule for the solution of Lagrange's equation had not received adequate demonstration.[1]

If $u = a$, $v = b$ furnish values of z in terms of x, y which satisfy the equation

$$P\partial z/\partial x + Q\partial z/\partial y = R,$$

where P, Q, R are any functions of x, y, z; and if $\psi(x, y, z) = 0$ be any other integral, then the condition $\frac{\partial [\psi, u, v]}{[x, y, z]} = 0$ must be satisfied, *not necessarily identically, but in virtue of the relation between* x, y, z *given by* $\psi(x, y, z) = 0$. It is only when the above condition is satisfied identically that ψ is a function of u, v. In this case ψ is certainly included in the general integral. But it is possible to take a case of the general integral, and put it into a form in which the Jacobian does not vanish identically; *e.g.* if $x\partial z/\partial x + y\partial z/\partial y = z$, we may take $u \equiv y/x$, $v \equiv x/z$, $\psi \equiv y/x - x/z$ and the Jacobian vanishes identically; but if we put $\psi \equiv yz - x^2$, then the Jacobian $= -2\psi/(xz^2)$, which vanishes only when the relation between the variables is such as to make $\psi = 0$. Finally, it is possible to have singular integrals, which cannot be expressed in the form of the general integral at all. In this case, let $u = a$, $v = b$ be two integrals, and let $f(x, y, z) = 0$ be any other integral, then by elimination of y, z express $f(x, y, z) = 0$ in the form $\phi(x, u, v) = 0$.[2]

Then if D denote partial differentiation when x, u, v are the independent variables, it can be shown that $PD\phi(x, u, v)/Dx$ must vanish, not identically, but in virtue of the relation between x, y, z given by $f(x, y, z) = 0$. Prof. Forsyth proves that if P, Q, R are regular for values of x, y, z in the vicinity of any point on the integral $f(x, y, z) = 0$, then this integral is included in the general integral. Taking as an example the equation

$$(1 + \sqrt{z - x - y})\,\partial z/\partial x + \partial z/\partial y = 2,$$

we may take

$$u \equiv 2y - z,\ v \equiv y + 2\sqrt{z - x - y};$$

and $z = x + y$ is an integral not included in the general integral. In this case

$$\phi(x, u, v) \equiv (1 - \sqrt{1 + v - u - x})^2,$$

and $PD\phi(x, u, v)/Dx = -\sqrt{z - x - y}$, which vanishes when $z = x + y$. In this case it is at once seen that the coefficient $P \equiv 1 + \sqrt{z - x - y}$ is not regular in the vicinity of points on the integral $z = x + y$.

A similar point, arising out of the conditional vanishing of a Jacobian, comes up in connection with Art. 12. It is there proved that an ordinary differential equation of the first order and degree, with coefficients which are one-valued functions of the variables, has only one independent primitive.

As soon as the reader reaches the subject of singular solutions, he is forced to ask himself why the reasoning in Art. 12 is inapplicable. He wishes to have an explanation of the fact that the many-valuedness of the coefficients causes the reasoning to fail.

Suppose the equation is $2dy/dx + x + \sqrt{x^2 + 4y} = 0$. Two primitives of this are $c^2 + cx - y = 0$ and $x^2 + 4y = 0$. Their Jacobian is $2(x + 2c)$, which does not vanish identically, but conditionally, viz., at the point of contact of the envelope $x^2 + 4y = 0$ by the complete primitive $c^2 + cx - y = 0$.

The method of Frobenius for integrating linear differential equations in series is explained on pp. 235–249, and is applied to the solution of Bessel's equation. It is of a more general character than the special method applied to the same equation in chapter v.; and it exhibits the connection between the two solutions found by it. The connection between the two solutions obtained in chapter v. is difficult to perceive; and Frobenius's method has the advantage both in directness and simplicity. It is a valuable addition to the book.

Runge's method for the numerical solution of differential equations has suffered somewhat in the compression which the author has found necessary. Nevertheless, one cannot help regretting the omission to state the geometrical meaning of the expressions employed, and the connection of the method with Simpson's rule for the approximate evaluation of an integral. The student will probably be greatly perplexed as to the origin of the various quantities introduced and used in the investigation.

There are several difficulties in the discussion of the differential equation which is satisfied by the hypergeometric series in chapter vi. Although the subject cannot be properly dealt with without assuming a knowledge of the theory of functions, which is not to be expected of the majority of the readers of the book, yet there are some very obvious difficulties which could be removed by short explanations.

[1] See Chrystal, *Transactions* of the Royal Society of Edinburgh, vol. xxxvi. part ii., p. 551 (1891).

[2] Or by eliminating z, x in the form $\psi(y, u, v) = 0$, or by eliminating x, y in the form $\chi(z, u, v) = 0$.

It is stated (Art. 122) that there is a linear relation between any three of the twenty-four integrals of the equation. The limitation that it is essential to consider only such groups of three integrals as have a common domain does not appear until we reach Art. 124, where it seems to contradict the statement in Art. 122.

The twenty-four integrals are divided into six groups of four each, and the members of each group of four are described as being equal. It should be pointed out that the members of each group of four fall into two pairs, that the members of one of these pairs are equivalent to one another, as they have the same domain; but they do not have the same domain as the members of the other pair (which are equivalent to one another). The four members of a group of four are equivalent to one another only in the domain common to them all. The integrals of one pair are to be regarded as continuations of the integrals of the other pair. From this it follows that in any linear relation between three of the integrals, it is not possible to replace any integral by another member of the group of four to which it belongs without examining whether the integrals appearing in the final relation have a common domain.

For example, relation No. (vi.), p. 219, viz.:—

$$Y_1 = M_5 Y_5 + N_5 Y_6$$

is intelligible if we take

$$Y_1 = F(\alpha, \beta, \gamma, x)$$

$$Y_5 = (1-x)^{-\alpha} F\left(\alpha, \gamma-\beta, \alpha-\beta+1, \frac{1}{1-x}\right)$$

$$Y_6 = (1-x)^{-\beta} F\left(\beta, \gamma-\alpha, \beta-\alpha+1, \frac{1}{1-x}\right)$$

because these integrals have a common domain. But it becomes meaningless if we replace

$$Y_5 \text{ by } x^{-\alpha} F\left(\alpha, \alpha-\gamma+1, \alpha-\beta+1, \frac{1}{x}\right),$$

which belongs to the same group of four integrals as that previously taken for Y_5; and if we replace

$$Y_6 \text{ by } x^{-\beta} F\left(\beta, \beta-\gamma+1, \beta-\alpha+1, \frac{1}{x}\right);$$

for Y_1, Y_5, Y_6 have now no common domain, except possibly points on the unit circle. This peculiarity had been noticed by Kummer in his memoir on the hypergeometric series. He held that even supposing we make the changes described above for Y_5 and Y_6, the equation should not be rejected as meaningless; for the two sides are now the expansions of the same function of x, one proceeding according to powers of x, and convergent inside the unit circle, the other proceeding according to powers of $\frac{1}{x}$ and convergent outside the unit circle; and he illustrated the subject by deducing from one side of one of the equations the expansion of $\tan x$ in powers of x, and from the other side of the equation its expansion in powers of $\frac{1}{x}$.

The whole subject received a thorough revision by Goursat (in the *Annales* de l'École Normale Supérieure, Sér. ii. t. x. 1881), who shows that in some cases the linear relations between the three integrals do not possess the same form throughout the whole of the plane of the complex variable. There still remains, however, for future researchers the discovery of an algebraic demonstration of such equations as the linear relation between

$$F(\alpha, \beta, \gamma, x), \quad x^{1-\gamma} F(\alpha-\gamma+1, \beta-\gamma+1, 2-\gamma, x),$$

and

$$F(\alpha, \beta, \alpha+\beta-\gamma+1, 1-x),$$

series proceeding respectively according to integra powers of x, non-integral powers of x, and integra powers of $(1-x)$, where, however, the last series cannot be expanded in integral powers of x.

The following details may be noticed:—

I. There is some obscurity in the explanation given in the note to Art. 25.[1]

If the system of curves $f(x, y, c) = 0$ have a node-locus let the node on the curve $f(x, y, a) = 0$ be given by $\xi = \phi(a)$, $\eta = \psi(a)$.

The node-locus will be found by eliminating a between the last two equations. The point to be explained is the reason for the appearance of this locus as a factor in the equation $\mathrm{Disct}_c f(x, y, c) = 0$.

The coordinates of the node on the curve $f(x, y, a+\delta a) = 0$ may be called $\xi + \delta\xi$, $\eta + \delta\eta$. Then the following equations hold:—$f(\xi, \eta, a) = 0$, $\frac{\partial f}{\partial \xi} = 0$, $\frac{\partial f}{\partial \eta} = 0$; and the equations which can be obtained from them by changing ξ, η, a into $\xi + \delta\xi$, $\eta + \delta\eta$, $a + \delta a$ respectively. Of this last set of three only the first is required, viz. $f(\xi + \delta\xi, \eta + \delta\eta, a + \delta a) = 0$. Neglecting quantities of the second order, and using the preceding equations, it follows that $\frac{\partial f}{\partial a}\delta a = 0$. Hence the values $\xi = \phi(a)$, $\eta = \psi(a)$ satisfy $\frac{\partial f}{\partial a} = 0$, as well as $f = 0$, and therefore the node-locus is a factor of $\mathrm{Disct}_c f(x, y, c) = 0$.

II. The properties of the Schwarzian derivative (Art. 62) may be thrown into a more symmetric form, viz:—

$$\{s, x\}(dx)^2 = -\{x, s\}(ds)^2$$

$$\{s, x\}(dx)^2 = \{s, y\}(dy)^2 + \{y, x\}(dx)^2$$
$$= \{s, y\}(dy)^2 + \{y, v\}(dv)^2 + \{v, x\}(dx)^2.$$

III. In Art. 192, the argument may be stated thus:—

It is given that

$$\frac{\partial\left[\frac{\partial F}{\partial \xi}, \frac{\partial F}{\partial \eta}\right]}{\partial[\xi, \eta]} = 0.$$

From this it follows that

$$\frac{\partial\left[\xi\frac{\partial F}{\partial \xi} + \eta\frac{\partial F}{\partial \eta} - F, \frac{\partial F}{\partial \xi}\right]}{\partial[\xi, \eta]} = 0.$$

Hence the equation of the tangent plane to the surface $z = F(x, y)$, viz. $z = x\frac{\partial F}{\partial \xi} + y\frac{\partial F}{\partial \eta} - \left(\xi\frac{\partial F}{\partial \xi} + \eta\frac{\partial F}{\partial \eta} - F\right)$ can, by putting $\frac{\partial F}{\partial \xi} = \lambda$, be expressed in the form $z = \lambda x + y\phi(\lambda) + \psi(\lambda)$, so that it is expressible in terms of a single arbitrary parameter λ. The quantities $\xi, \eta, \frac{\partial F}{\partial \xi}, \frac{\partial F}{\partial \eta}$ are not all functions of a single parameter.

IV. The solutions of Laplace's equation, which have

[1] The word "discriminant-equation" in the fourth line should be "differential equation."

been discovered since the second edition of this book was printed, and in which the author has himself borne an honourable part, are, if we except an example very near to the end of the book, not mentioned.

THE MAGNITUDE OF THE PROTEINIC MOLECULE.

Die Grösse des Eiweissmoleküls. By Dr. F. N. Schulz. Pp. viii + 106. (Jena: Gustav Fischer, 1903.) Price 2.50 marks.

THIS work is the second part of the author's "Studien zur Chemie der Eiweissstoffe"; the first part is entitled "Die Krystallisation von Eiweissstoffen und ihre Bedeutung für die Eiweisschemie," and is also published by Gustav Fischer.

The book is composed of five chapters. The first deals with elementary composition as a measure of the magnitude of the proteïnic molecule, and fills twenty-four pages. In it the author discusses firstly the ash of proteïns. This he divides into essential and non-essential parts, without predicating chemical essentiality of the former. He concludes that the ash is of no value for the purpose under consideration. He deals next with the sulphur, and shows that it can be used to give minimal values. It is pointed out how the difference in the ease of its elimination affects the results, and the methods of its determination are discussed.

In the second chapter the products of substitution are considered. This chapter contains fifty-three pages. Of the natural bodies oxyhæmoglobin and caseïn are the only ones lending themselves to calculation. Consideration of artificial products yields no figures of value at present. The substances resulting from association of acids and bases with proteïns are not as yet available for purposes of calculation. The same may be said of those of metals with proteïns, with the possible exception of Harnack's copper-albuminates. The author points out, however, that these substances need closer study.

In connection with these bodies the author diverges into a consideration of certain properties of colloids, and indicates that associations of colloids may simulate chemical compounds. He states emphatically that use of such words as *combination* and *compound*, in the case of certain proteïns and proteïnic derivatives, may be unwarranted:—

"Eine Hauptaufgabe dieser Abhandlung war es gerade, dass gezeigt wird, dass bisher *keine zwingenden Gründe* vorliegen, um z. B. bei den Metallalbuminaten, oder später bei den Halogenalbuminaten, Verbindungen der Eiweissstoffe nach stöchiometrischen Gesetzen annehmen zu müssen."

The products of interaction of proteïns and halogens (especially iodine) are dealt with at some length. The absence of harmony in the results of different observers is shown, and the complexity of the process is pointed out. The conclusion is reached that these substances are not yet trustworthy for computational purposes.

The subject is regarded in the third chapter from the aspect of the products of hydrolysis, and it is found that no single compound is of use for the required calculation. The chapter contains nine pages

The fourth chapter, which consists of six pages, deals with physical methods, and chiefly with the cryoscopic one. The author has again to regard the results with suspicion, owing to the ash and the undefined nature of the substances. There is apparently an indication that the molecular masses of peptones, proteoses, and more complex proteïns stand to one another in a series of increasing magnitudes. The numbers attached to the two former classes may be of the right order; those connected with the latter are, however, valueless.

The final chapter, containing four pages, is devoted to conclusions. The author considers that the present state of the subject is very unsatisfactory, and that the molecular magnitudes of the more complex proteïns cannot be even given with approximate certainty. Selected minimal values, as those of Vaubel, lying for the more complex proteïns between 5000 and 15,000, can be made to give apparent harmony. But, if selection is not made, the result is very different.

The necessity of starting with crystalline bodies, and of improved methods is emphasised. The author also lays stress on the necessity of studying proteïns in their colloidal aspect, saying:—

"Ich bin der Meinung, dass eine gründliche Erforschung der colloidalen Eigenschaften der Eiweisskörper, das Räthsel der Eiweisschemie eher aufklären wird, als eine detaillirte Untersuchung der Krystallinischen Eiweissspaltungsproducte."

He adopts throughout a position of impartial criticism, which is eminently sound. The results hitherto obtained have for him no great positive value at present; this he attributes to insufficient precision in the modes of investigation, although admitting that the cause may be inherent in the proteïnic nature.

Some might urge that publication is in these conditions premature. But in the present state of proteïnic chemistry such a pamphlet as this, permeated with sane criticism, and summarising what is known in a clear and agreeable manner, can only be of value. The just appreciation of the extreme importance of a study of the colloidal nature of proteïns is a main feature of the work.

It is a regrettable fact that no index of subject-matter is appended, although there is one of authors, and a table of contents. F. ESCOMBE.

PHYSIOLOGICAL REPORTS.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by Sir John Batty Tuke, M.D., and D. Noël Paton, M.D. Vol. viii. (Edinburgh: Oliver and Boyd, 1903.)

THIS volume represents the work done in the laboratory in 1900 and 1901, and though a year late in its appearance is none the less welcome for that. Apart from one paper on the pollution of the Tyne Estuary, it is devoted to pathology and physiology.

Throughout there are records of the energy and helpfulness of the superintendent, Dr. Noël Paton, and no less than one-third of the articles are by him, either alone or in conjunction with others. Indeed, his

interests are perhaps too multifarious, for one or two of his papers seem to have come into print before the observations they contain were ripe for publication.

Nothing, however, could be more elaborate or painstaking than the opening article, a study of the dietary of the labouring classes of Edinburgh, of which the expenses were partly defrayed by the progressive Town Council. The details were procured by a band of lady students, and are often amusing if not always essential. Thus we are glad to learn that a lady who dresses "in the Canongate fashion of a loose blouse" gets on well with her neighbours, but tragic possibilities follow on our introduction to the husband; "Mr. T. is not a teetotaler and he smokes."

The most interesting result of the study is the startling discovery that porridge is rapidly disappearing as a staple article of diet with these people. In fact, the investigation might have been entitled "A Plea for Porridge," for the authors rightly insist upon its economic value.

Of the other articles, the longest is a contribution to the histology and metabolism of the fœtus and placenta of the rabbit, by Dr. Chipman. With so difficult a subject, and so confused a terminology, the author's lucidity of style is very welcome, and the illustrative microphotographs, numbering no less than 186, are eloquent of his sincerity. He throws light on many controversial points, *e.g.* the manner of first contact of the embryonic and maternal tissues, the "unequivocal differentiation" of these two tissues, and the relations of placental and fœtal glycogen. It is a pity that he says nothing of the glycogen in the fœtal muscles, where it is said to exist sometimes to the extent of 40 per cent. of the dried tissue. There is much about the formation of "fibrinous tissue" from extravasations of blood, but he ligatured the vessels at the outset to ensure, as he explains, an injection of the placentæ, and we would suggest that these extravasations may have been, in part, an artefact.

Dr. Rainy's paper on the action of diphtheria toxin on nerve cells is so excellent, so far as it goes, that we look forward to a further instalment next year. He obtains very definite intracellular effects, and avoids error by a most thorough series of controls. Also he gives an admirable history of the subject.

There are many other minor articles of varying value. Dr. Carmichael, working at the infections of the gall-bladder, injected microorganisms into a mesenteric vein in five rabbits, and since he gets but one positive result, he concludes that infection can occur only by direct extension or by the cystic artery; of such factors as the virulence of the organism, the nature of the animal, and the condition of the gall-bladder he takes no account.

We are glad to see that Miss Huie is continuing her observations on the histology of cell-metabolism which she began so successfully in Oxford. Dr. Dunlop, in some observations on prison diets, confirms Atwater's finding that Voit's classical standard of diet is too low. Finally, we would mention a curious study by Dr. Berry in comparative morphology, in which he concludes that the vermiform appendix is not vestigial but the summation of a long development.

OUR BOOK SHELF.

An Elementary Treatise on the Mechanics of Machinery, with Special Reference to the Mechanics of the Steam Engine. By Joseph N. Le Conte. Pp. xi+311; with 15 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1902.) Price 10*s.* 6*d.* net.

THE author states that this book is the outcome of a series of lectures given to engineering students in the University of California.

In an introductory chapter relating to uniplanar motion, some properties of instantaneous centres and centrodes are given, and methods are set out of determining relative velocities, both linear and angular.

The next part is devoted to machinery of transmission, comprising rigid and flexible couplings, friction gearing, belt and rope gearing, and toothed gearing, the shafts being parallel, intersecting, or crossing, respectively. This part also includes chapters on parallel motions and cams.

The author has a leaning towards analytical rather than graphical treatment, and prefers accurate and complete investigations to simplified approximations. This is apt to result in formulæ which convey little meaning, and which repel by their complexity, requiring the subject-matter to be of great importance to justify their use. Thus in the discussion on wheel teeth there is an investigation into the equation to the profile which shall correspond with any given curve of action; and formidable expressions are given for calculating the angles of action in cycloidal and involute teeth. We should like to have seen these supplemented by graphical methods, using tracing paper and a pricker, after Mr. Last, whereby wheel teeth can be set out with perfect accuracy, with the minimum of trouble, and in such a way as to bring very prominently into notice the nature of the action between a pair of teeth.

Part iii. deals with the steam engine, the first chapter relating to the kinetics of the "piston-crank chain." Accurate formulæ are established giving the position, velocity and acceleration of any point moving with the connecting rod referred to the crank position, from which are deduced the special values for the centre of mass, the crosshead and crank pin. Formulæ for angular motions of the connecting rod are also given. In this chapter the simple and gridiron slide valves are considered, and also the Meyer and Thompson gears, Zeuner's valve diagram being used along with the formulæ.

Chapter ii. of this part is taken up with the dynamics of the steam engine, and investigates piston and crank efforts, inertia effects, counterbalancing, and the actions of the fly-wheel and governor. The formulæ of the preceding chapter are used to calculate the force actions in a small horizontal engine due to acceleration of the connecting rod for a number of points in the cycle; these are tabulated, and the results plotted in plates at the end of the volume.

In the mechanics of the steam engine, the use of the Fourier development, with the conception of rotating vectors, is preferable to the method adopted by the author. The series converges so rapidly that it is seldom necessary to go beyond the second or octave term, and a very clear view is obtained of the secondary actions due to obliquities of the connecting and eccentric rods.

The principle of balancing the forces on the crank-shaft of an engine, ignoring those on the frame, is novel, and leads to curious results in the case of the Southern Pacific locomotive selected by the author as an example.

The investigation of the action of fly-wheel governors seems very complete, and is worth study.

Elementary Chemistry. By R. H. Bradbury, A.M., Ph.D. Pp. xii+157. (New York: Appleton, 1903.) THE volume, according to the author, is for beginners in secondary schools and colleges. Whether this implies any previous knowledge of chemistry on their part is not stated, but, to judge from the character of the contents, the book may be placed in the hands of any beginner. The author has evidently taken great pains to arrange his subject-matter, and to present it in a simple and logical form—not by any means an easy task—and the result is decidedly good.

It is always possible to find points in the arrangement of a text-book which do not accord entirely with one's own views. For example, the first chemical experiment which is described is the electrolysis of water to demonstrate its composition. It is difficult to present this process honestly to the beginner. The author does his best by stating that "it is impossible to explain the *rôle* of the sulphuric acid in an elementary work, further than to say that while it conducts the current it is found unaltered after the experiment, and only the water is decomposed." After all this is only dodging the difficulty, which might be so easily avoided by reserving the experiment for a later stage, when the author could take the reader into his confidence.

The author in his preface acknowledges his indebtedness to Bancroft's work on the phase rule and to the work of another modern writer on physical chemistry, but the elementary student will be relieved to find that no reference to the phase rule, and very little to "physical chemistry," is embodied in the text. Arrhenius's theory of electrolysis is, however, introduced, and there can be little objection to this, seeing that a student may just as well begin to exert his imagination on the atoms in solution as in the gaseous form. It is just as difficult to form a mental picture of charcoal as a constituent of carbon dioxide as of the ion CO_3. The only difference between the two conceptions is that one is a demonstrable fact and the other a very useful fiction.

An important feature of the book is the experimental part which is to be used as a laboratory guide, and contains a series of simple and useful experiments plentifully sprinkled with questions and notes of interrogation. The volume is, in reality, two distinct books with separate indexes. Might one suggest their future publication in separate parts; for not only is it difficult to remember that the index to the first part is in the middle of the volume, but as the second part is for use in the laboratory, the whole book, which looks very nice in its olive-green cover, is bound to suffer from the proximity of reagents?

The book is well illustrated, and is further embellished with the portraits of ten distinguished chemists, among whom Moissan has the place of honour in the frontispiece. J. B. C.

Hampshire Days. By W. H. Hudson. Pp. xvi+344; illustrated. (London: Longmans, Green and Co., 1903.) Price 10*s.* 6*d.*

THE author of "The Naturalist in La Plata" has found a thoroughly congenial subject in Gilbert White's country, and discourses, in the work before us, in a delightfully gossipy way of the scenery, people, birds, insects, and plants of one of the most beautiful of all English counties. As usual, Mr. Hudson introduces, when occasion arises, earnest trains of thought, which raise his work far above the average of writings of this nature.

The greater part of the contents of this volume, we are told in the preface, is new, although nearly the whole scope of the work is based on certain articles which have appeared in *Longman's Magazine.* Although devoted as a whole to Hampshire, the book, as might be expected, mentions many episodes which might perfectly well have happened in any other English county. Notable among these is the account of the manner in which a young cuckoo ejected the rightful occupant—a robin—of the nest in which the intruder was hatched, an action of which the author was fortunate enough to have been an eye-witness. Perhaps the most curious feature in this drama was the utter neglect of the ejected and dying robin by its parents. In another part of the same chapter the author directs attention to the prevalence of red in the coats of forest animals at the time that the autumn russet prevails in their surroundings. He has, however, omitted to mention that it is just before this season the red deer and the roe change their summer russet for their winter blue.

The account of Selborne itself is continued in the latter half of the book. Over the natural beauties of the village and its surroundings, the author, needless to say, waxes eloquent, although he is far from complimentary to the personal appearance of its inhabitants. After writing the sentence that "if you want to see, I will not say a handsome, nor a pretty, but a passably fresh and pleasant face among the cottagers, you must go out of Selborne to some neighbouring village to look for it," will the author, we wonder, venture to pay another visit? We cannot, perhaps, bestow greater praise on Mr. Hudson's "Hampshire" than by saying it is fully equal to the best of his earlier efforts.

R. L.

Wörterbuch der philosophischen Grundbegriffe. Von Dr. Friedr. Kirchner. Vierte neubearbeitete Auflage von Dr. Michaëlis. Pp. vi+587. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1903.) Price 5.60 marks.

IT is always difficult to indicate exactly the value of a dictionary, and that difficulty is increased when for the vices of omission it pleads the virtues of brevity. A dictionary of philosophy is hardest of all to judge because of a certain inner conflict between the spirit of philosophy and the nature of dictionaries. If the publishers feel justified in saying that this book responds to a widely felt need, we must admit that a fourth edition seems good evidence. To judge from the book, that need is for brief epitomes of great doctrines and concise definitions of terms. Terms of art are a fit subject for the lexicographer, more especially such remnants of constructive ingenuity as "Häcceität," "Aseität," and the like. But philosophical concepts and theories are not so tractable; here brevity is an ambiguous virtue, and the more ambitious articles seem to be so planned as to have full significance only for the more advanced student who, on the other hand, would bring to the book all he found there. "Kantianismus," for example, occupies two-thirds of a page. Of "Hedonismus" in modern times we learn only that it is more modest than of yore; where the term explained is one in common use, the strictly philosophical significance is omitted; *e.g.* under "Liebe (ἔρως)," the Platonic and Neo-Platonic significance is unmentioned; the direction "Vgl. Dualismus" seems purely illusory. Biography does not come within the scope of this book, but the references are usually given with dates. At the end there is a "Zeittafel" which might well be useful. It seems a matter for regret that the terms of the "new psychology" have not been included; they might at least outrival "Buridans Esel" or "Krokodilschluss" as Grundbegriffe. Yet allowing for these limitations, the book is a praiseworthy effort; it is generally accurate, sensibly printed, and of a useful size. Such eccentricities as "Hutcheson 1609–1747" (p. 14) can be corrected by the reader from the "Zeittafel." The bibliography attempted in some articles is a good feature worthy of more development.

G. S. B.

LETTERS TO THE EDITOR.

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

Psychophysical Interaction.

SINCE NATURE is read by many people beside physicists and mathematicians, it may be useful to state explicitly that a letter with a diagram, on p. 102, is erroneous and misleading.

For the same reason it may be desirable to remark distinctly, in opposition to a notion *apparently* suggested by several previous writers, that guidance or deflection of motion is not in the least contradictory of the principle of the conservation of momentum. For the rest, all the letters of importance which have recently appeared are in accordance with my views. OLIVER LODGE.

I HAVE followed with much interest the discussion opened in your columns by Sir Oliver Lodge's recent contention that mind directs but does not create energy. What is aimed at, as I understand it, by this distinction is the reconciliation of the activity and efficiency of mind with the mechanical laws of the conservation of energy and momentum. The distinction itself is, as is well known, as old as Descartes, being designed by him to meet the same problem as it presented itself to the thinkers of the seventeenth century. As is also well known, it was immediately disowned by his successors on the ground that guidance or direction of energy by the mind is an interference with the operation of material forces as the physicist is bound to conceive of them not less than the creation of it. Why is it more inconceivable that mind should alter energy or momentum than that it should interfere in any way whatever with the material world as a closed mechanical system? While to Sir Oliver Lodge it seems axiomatic that mind cannot produce energy, to others it has seemed equally axiomatic that it cannot resist or control it. It remains, therefore, for those who propose to revive the above distinction as a way of making the relation of mind to matter comprehensible to show by an analysis of the conception of control that the direction of physical energy by the mind is any more intelligible than its creation. Failing this, the problem they have sought to solve by means of this formula only returns in a deeper form. How is mental efficiency in any shape to be reconciled with fundamental mechanical principles? The purpose of this letter is to suggest a form of solution, somewhat different from that of Prof. Ward's in his "Naturalism and Agnosticism," which makes recourse to so ambiguous a distinction unnecessary.

Stated in its most general form, the problem is that of the operation of mind upon matter. Three answers have stood out owing to the authority of those who at different times have advocated them :—

(1) It has been held that mind and matter are each in its own sphere effectively operative, but that these spheres are wholly different. They never touch or intersect. Where there appears to be coincidence, as in knowledge or in the action of one upon the other, this is to be explained (if an explanation is insisted on) as the result of pre-arrangement. Except in the form of the working hypothesis of parallelism, no responsible thinker would probably accept this "dualistic" theory at the present time, and it need not further be considered.

(2) The second answer is that which explains mental activity as merely apparent. The really active forces are material. Consciousness is merely a by-product, standing to material forces as the steam which is dissipated in the air stands to the steam-engine—a sign of its operation, but itself contributing nothing to its efficiency. This "materialistic" theory is surrounded by difficulties which this is not the place to discuss, but which the present generation seems to be in the main agreed are insuperable.

(3) A third view remains which takes up the problem at an earlier point, and asks whether our difficulty is not a self-made one. If we set out from the existence of mind and matter as two entirely separate substances, there is, it must be admitted, no way in which we can establish any continuity or causality between them. On the other hand, if we reverse this assumption, and regard the conception of two worlds, a physical and a mental, as one that grows up within (it is not said created by) our experience, a way seems opened up out of the difficulty. The conservation of energy and momentum, and the determination of their direction by physical antecedents, are from this point of view conceptions which are forced upon us in our endeavour to interpret to ourselves one side or aspect of our experience—that which we call the mechanical. Within the area so describable they are universal, ultimate, admitting of no exception. But the mechanical is only one side of our experience. Besides mechanical energy there is life. The phenomena of life violate no mechanical law, yet open up to us a new aspect of our world, a new form of "energy." We may, indeed, try to "explain" life as only a more complex mechanism, and this has been a common device since the time of Descartes. But the present day tendency to recognise here a *transitio in aliud genus*, and to reject (as leading to confusion) the attempt to explain the fuller, more concrete reality by formulæ applicable only to the more abstract, seems to be founded on a truer insight. What holds of the relation of life to mechanism holds also of the relation of mind to life in general. Here also a new world opens up with laws of its own, no more identifiable with those of matter or organism than the system of mechanical forces which make up the movement of the billiard ball upon the table or the contraction of the muscles in the player's arm is identifiable with his acquired dexterity or his gaming ambition.

"But how," it may be asked, "does all this help us? Granted the world of Nature has these different 'sides,' we are no nearer understanding how any one side is connected with another, least of all how the 'world as will and idea' is connected with the world as matter and energy." It is just here that I wish to invite the physicist who may not have considered the question in this light to make an experiment with his ideas which may not hitherto have suggested itself, and when suggested may appear to him as ridiculous as an invitation to vary his outlook upon the universe in the interest of science by standing upon his head. The suggestion is that instead of starting, as probably he has been accustomed to do, from the presupposition that the entirely real and concrete is what is known as the physical world, and that everything else must fall into line as in some sense a product or reflection of it, he should start from his own experience as a whole—his mind and will as it exercises itself in the world of reality in general, including, of course, other minds and wills—as though this were the primary, most entirely real and concrete fact that he knows, and regard all else as comparatively abstract and secondary. The former view I invite him to consider for the time being as analogous to the old Ptolemaic astronomy, the latter as the Copernican. When he has done so I ask him further to consider whether the operation of mind on matter need any longer constitute the insoluble problem the older hypothesis made of it. Putting aside the question of the relation of our individual minds to the mind of the Creator, the single "real" activity is from this point of view that of a conscious will in presence of a universe which it is its one supreme interest to understand and adapt to its own ends of life and well-being. The condition of such understanding and adaptation is selection and abstraction; its one supreme law *divide et impera*. A fundamental division at which developing experience early arrives is that of an inner and an outer—a self and other. A subdivision of the latter, which it is not long in achieving, is into the material other and the mental other—the physical and the social world. In this way the division proceeds, but always into parts of a whole of which we must keep a hold and to which we must ever return wherever the danger threatens of becoming the victim of our own abstractions. Treated as an articulate part of the whole, each field falls into its place in the organism of experience—general philosophy being the attempt to state what that place is; when hypostatised into an independent reality, still more when mistaken for the whole it leads only to confusion. From the beginning of speculation the front of the offending has here lain with Matter. Philo-

sophy from the time of Plato has had its own way of meeting it on its own ground, and disposing of its exclusive claims. I do not write here in the interests of transcendentalism, but merely to invite the attention of physicists to a point of view which students of modern psychology have borrowed from it, and are now generally seeking to apply to the problem of the relation between mental and physical energy. J. H. MUIRHEAD.

Birmingham, June 9.

Seismometry and Gēite.

HAD Dr. Chree (NATURE, May 21, p. 55) referred to the various papers about earthquakes in the reports of the British Association commencing in 1847 by William Hopkins, in the now somewhat antiquated *Transactions* of the Seismological Society of Japan, and in very many other publications relating to earthquakes, he would have seen that his instructive remarks relating to the propagation of waves in an isotropic medium were but repetitions of information with which seismologists have at least a slight acquaintance, whilst the suggestion that the velocities of such waves have been regarded as having a direct connection with Young's modulus is incorrect.

In connection with Bessemer steel, Young's modulus was mentioned, but I do not see that it was referred to repeatedly (NATURE, April 9, p. 538). In 1897 Dr. Chree made an attempt to calculate Young's modulus and the bulk modulus for the earth, but the grist he used was so doubtful in character that his results are not convincing. From some source or other he discovered that wave velocities of 12·5 and 2·5 km. per second had been determined, and these were assumed to be V_1 and V_2 for compressional and distortional waves passing *through* the world. One, if not both of these, are based upon *arcual* measurements; they are incorrect at that, and the latter seems more likely to represent the velocity of a surface undulation rather than a quantity corresponding to V_2.

What I pointed out was that recent determinations of a quantity probably corresponding to V_1 find a simple explanation by the assumption of a core that is fairly *homogeneous* and of fairly *definite dimensions*, which is not the solution of the seismological problems attempted by Dr. Chree. The reference to elastic moduli was incidental.

The chief objection raised to the iron core is not that iron, as we know it, will not convey vibrations at the observed speeds, but that if we take such a core, gravitational and astronomical requirements appear to be such that it must have dimensions which do not altogether accord with the interpretation given to seismometrical observations.

What Dr. Chree tells us about the possible relationship between seismic disturbances and the movements of magnetic needles is as well known to seismologists as what he has to say about wave velocities. Many of the chief magnetic observatories of the world have compared their magnetograms with long lists of world-shaking and other earthquakes, and the results are to be found in the British Association Reports, 1888 and 1889. From Dr. Chree's own comparisons at Kew (British Association Report, 1888, pp. 229 and 231, &c.), the movements he discovered were, with two possible exceptions, of "the ordinary magnetic small wave type," which "go on for hours if not for days." My conclusion is that at Kew, Greenwich, &c., needles seem not to be disturbed at the time of large earthquakes in the manner in which they are disturbed at Bombay and other places. At these latter places, where the movement of needles apparently accompanying the passage of the large waves indicates a possible magnetic disturbance directly due to seismic causes, the inference I made was that at such places H.F. and $(g-\gamma)$ may be abnormal. As an illustration of the coexistence of the *three* phenomena we may take the following:—

	H.F. (c.g.s.)	$(g-\gamma)$ cm.	Earthquake effect on magnetic needles
Kew	0·18451 (1901)	+ 40 (1900)	Undisturbed.
Batavia	0·36752 (1898)	+136 (1894)	Disturbed.

Whether these coincidences are accidental or general, observations are yet required. JOHN MILNE.

THE VITALITY OF THE TYPHOID BACILLUS.[1]

THE object of hygiene is to prevent disease. It is therefore necessary that the factors in the causation and dissemination of disease should be understood in order that adequate preventive measures may be adopted. The living agents responsible for the production of infectious diseases when they are discharged from affected individuals may find their way back to the human body by a number of indirect channels. The water, the soil, or the food may at times harbour and transmit the germs of disease. The conditions under which these morbid agents exist in the outside world constitute one of the most important subjects of hygienic inquiry. It cannot be said with regard to this phase in the life-history of pathogenic organisms that our knowledge is as accurate or extensive as it is in other directions. This is due to the difficulties that stand in the way of such investigations. The germs of disease undergo an enormous dilution in the air, water and soil, whilst they tend to become lost in the crowd of similar forms already existing in nature. The facts so far support the view that the parasitic microorganisms possess a considerable amount of resistance to external influences, and that the links which ensure their conservation and re-transference to man are numerous and varied. A typical example is the bacillus of typhoid fever. This organism may become widely distributed through the dejecta. It may contaminate a water supply and directly, or by the agency of milk, produce a fresh outbreak of typhoid fever. It may infect the soil, and through it a number of raw vegetable foods. Its presence has been detected in the sewage-fed oyster, whilst tainted dust and flies aid in the distribution of the organism.

In studying the distribution of enteric fever, a physical factor which has to be considered is the influence of cold on the vitality of the specific organism. The effect of low temperatures upon microorganisms generally has formed a subject of inquiry from time to time. The latest experimental work has conclusively shown that bacteria retain their vitality under the most adverse conditions of cold that it is possible to devise. Prof. Sedgwick and Mr. Winslow, approaching the subject from the hygienic point of view, have carefully studied the influence of natural and normal conditions of cold upon the typhoid bacillus in particular. Their experiments were carried out with special reference to the danger of conveyance of the disease in question by polluted ice, and with reference to the seasonal distribution of the disease. The matter was undoubtedly one that called for investigation, and notably in a country where ice and iced drinks are in such universal demand. The authors were unable to find any recorded evidence of a conclusive character as to the spread of typhoid fever by a polluted ice supply, although it has been a common opinion that ice might be an important source of infection for typhoid fever and other intestinal diseases.

The apparent purity of ice is deceptive. It is true that water in freezing undergoes a certain amount of purification. It loses, on conversion into ice, saline constituents, contained air, and a certain proportion of organic suspended matter. At the same time, it is not entirely freed from microbes. The figures quoted by Prof. Sedgwick and Mr. Winslow show that snow-ice may contain an average of more than 600 bacteria per cub. cm. Figures are also given to indicate the enor-

[1] Experiments on the Effect of Freezing and other Low Temperatures upon the Viability of the Bacillus of Typhoid Fever, with Considerations regarding Ice as a Vehicle of Infectious Disease." By William T. Sedgwick, Ph.D., Professor of Biology, and Charles-Edward A. Winslow, S.M., Instructor in Biology in the Massachusetts Institute of Technology (*Memoirs* of the American Academy of Arts and Sciences, vol. xii. No. 5, 1902.)

mous number of bacteria present at times in ice-creams —one of the highest records being seven millions in one cub. cm. The sources of danger in ice-creams are obvious, as they come from the spoons and vessels, and the persons and dwellings of the street vendors.

Laboratory experiments have confirmed the conclusion that a freezing process is not necessarily fatal to bacterial life. We have instances of bacteria multiplying at zero, and of their survival after a six months' exposure to the temperature of liquid air. It is not therefore surprising that the American observers were unable to secure a complete sterilisation of bacterial cultures by the freezing methods they employed. The question became therefore a relative one. What was the probability or likelihood of infection through ice in the case of typhoid fever? It would appear that about 90 per cent. of the ordinary water bacteria are eliminated by the process of freezing. The authors find that, in the case of a specific pathogenic organism such as the *Bacillus typhosus*, less than one per cent. survive simple freezing for a period of fourteen days. Complete sterility did not occur even at the end of three months, whilst a process of alternate thawing and freezing, if on the whole more fatal to the typhoid germs than a simple freezing, was equally unsuccessful in effecting an absolute sterilisation of the infected water. The reduction in the number of typhoid bacilli in chilled water was approximately as great as occurred in ice. The process of destruction proved to be a continuous one, whether it occurred above or below the freezing-point, and whether the experiments were made in water or in soil. A progressive reduction in the number of organisms occurred to the extent of about 99 per cent., and proceeded *pari passu* with the duration of the experiment. Cold exercises a disinfecting action as regards the typhoid bacillus, and in natural ice there is a supplementary purifying influence to be taken into account, as, at the time of freezing, 90 per cent. of the germs are thrown out by a process of physical exclusion. These are the main conclusions arrived at, and the authors find that they are in accord with the general result of experience, namely, that natural ice can very rarely be a vehicle of typhoid fever.

The research may perhaps fairly be described as a study of the death-rate of typhoid bacilli under adverse conditions, as furnished by cold. The percentage mortality, as a matter of fact, is such as might occur under the influence of light, a poor food supply, and disinfectant agents generally. It is therefore permissible to think that the danger of infection in the case of ice, if it is minimised, is not by any means abolished. A certain number of typhoid bacilli, as the experiments show, do remain alive, and these may, on rethawing, undergo a rapid multiplication outside as well as inside the human body. And it has likewise to be remembered that it is notoriously difficult to trace the exact channels of infection in sporadic cases of typhoid fever. The infection has at times occurred from the most unexpected quarters.

Prof. Sedgwick and Mr. Winslow have rightly drawn attention to the unfavourable conditions furnished by natural ice for the propagation of the typhoid organism. It is at the same time feasible to assume that ice may likewise act as a conserving agent, inasmuch as the cold, whilst inhibiting the growth of the typhoid bacillus, will equally prevent the multiplication of other competitive forms of life.

The experiments do not affect the general question of the persistence of life at low temperatures. If the temperature be sufficiently low to produce a complete anæsthesia of the cells, cold tends to act as a conserving agent on the typhoid bacillus and allied forms.

It only remains to commend the memoir of Prof. Sedgwick and Mr. Winslow to the attention of all who are interested in the epidemiological questions involved.

ALLAN MACFADYEN.

NOTE ON THE PROBABLE OCCASIONAL INSTABILITY OF ALL MATTER.

AS a summary of my remarks at the discussion on Prof. Rutherford's most interesting communication on the subject of radio-activity to the Physical Society of London on Friday last, June 5, I beg to communicate the following :—

Consider an electron or other particle, of mass m and of negative charge e, revolving at speed u round the much more massive rest of an atom possessing an equal positive charge. The centripetal force between them is

$$\frac{mu^2}{r} = \frac{e^2}{\mathrm{K}r^2},$$

where the first r strictly is measured to the centre of gravity of the two bodies, and the second r is the distance between their centres; but taking these as usual practically equal for the lighter body, we get Kepler's law for the case

$$ru^2 = \text{const.} = \frac{e^2}{\mathrm{K}m} \quad \ldots\ldots (1)$$

Larmor has shown ("Æther and Matter," p. 227) that an electric charge subject to acceleration radiates some of its kinetic energy, though the radiation becomes of prominent amount only when the acceleration is great; as, for instance, when kathode rays are suddenly stopped by a target. The "power" of the radiation, or the energy lost per unit time, is

$$\mathrm{R} = \frac{2\mu e^2 \dot{u}^2}{3v} \quad \ldots\ldots (2)$$

where $\dot{u}$ is the acceleration of the electric charge e, and v is the velocity of light.

In the case of steady circular motion, the only acceleration is normal or centripetal, viz.

$$\dot{u} = u^2/r \quad \ldots\ldots (3)$$

but that is just as effective for radiation purposes as the tangential variety.

Hence, combining the three equations, we get, for the radiating power,

$$\mathrm{R} = \frac{2}{3\mu} \cdot \left(\frac{m}{e}\right)^2 \cdot \frac{u^8}{v^5} \quad \ldots\ldots (4)$$

that is, a constant multiplied by the eighth power of the velocity of the rapidly moving particle: an expression which corresponds with what for ordinary molecular motions is known as Stefan's law, connecting radiation with temperature, *i.e.* with square of molecular velocity.

Now the radiation loss is equivalent to a resisting medium, and accordingly the revolving particle tends to move inwards towards its centre, and its speed to increase in accordance with equation (1). A slight increase in speed brings about a great increase in radiating power, as is shown by equation (4); wherefore the change, once appreciably begun, may be expected to go on rapidly, until presently the speed approaches the velocity of light. On the electric theory of matter, radiation or loss of energy must occur from every atom, and therefore it is only a question of time how long an atom shall last before it reaches this stage.

Directly this stage is reached another effect supervenes; the rapidly moving portion of the mass begins rapidly to rise in value, according to a complicated expression not yet quite fully worked out. This effect

is unimportant until the speed comes very near to the light velocity, but the mass becomes suddenly infinite or very great when the light velocity is attained.

I find it difficult to realise the full effect of this kind of increase of mass, that is to say, of mass intrinsically possessed by the moving body, and not accreted on it from outside stationary matter. The latter effect is familiar in raindrops and in viscosity of gases, and it tends to reduce relative motion; but no previous instance is known where the mass of the moving body rises because it is itself a function of velocity. It would seem that the momentum must increase, and must disturb the balance of forces holding the parts of the system together. In an extreme case it might happen that the lighter body would suddenly become the heavier, would behave as if it had encountered an obstacle, and would jerk the rest of the atom off; or, on the other hand, it might happen that the most rapidly moving portion itself, by reason of its sudden access of momentum, would break loose and proceed tangentially. In any case it appears likely that an atom at this stage would begin to break up, as observed experimentally by Rutherford and Soddy; in other words, the fact of electronic radiation seems to carry with it the liability to change or decay of all matter possessing an electric constitution; the change from one form to another being accompanied, as they demonstrate in many cases, by radio-activity—a phenomenon which Strutt finds widely diffused.

It is hardly necessary to direct attention to a sort of astronomical analogy to this, though governed by different forces, in the contracting or gradual collapsing of a nebula, with the occasional shrinking off of peripheral material as an unstable stage is periodically reached, in accordance with the rough approximation known as Bode's law, together with the strong radio-activity of the central mass, and the conversion of constitutional potential energy into heat.

A few more words on the increase of mass at the critical velocity:—The only expression for mass as depending on velocity which has met with any attempt at experimental verification, is the expression of Abraham supposed to be verified by Kaufmann by direct experiment on curvature of kathode rays. Taking this as a simple example of the kind of effect to be expected, viz.

$$\frac{m}{m_0} = \frac{3}{4\beta^2}\left(\frac{1+\beta^2}{2\beta}\log\frac{1+\beta}{1-\beta} - 1\right) \quad . \quad . \quad . \quad . \quad (5)$$

where β is the ratio u/v, the speed of an electric particle to that of light, and m_0 its ordinary purely electric mass for slow motions, we find that when an electron is moving with *half* the speed of light, its mass is only 1.12 times what it was when stationary. At *three-quarters* of the speed of light the mass ratio becomes 1.37, or little more than a third greater than its normal value. At *nine-tenths* of the light velocity the mass is still not doubled, being only 1.8 times m_0.

When within 1 per cent. of the light speed the mass is trebled, or, more exactly, multiplied by 3.28, and when within one part in a thousand of its limiting velocity, the mass is almost exactly quintupled.

For higher speeds, say within $1/n$th of the speed of light, or $u=(1-1/n)v$, n being great, the expression for the electric mass ratio simplifies to

$$m = \frac{3}{4}\left\{\log(2n-1) - 1\right\}m_0 \quad . \quad . \quad . \quad . \quad (6)$$

which ultimately is truly infinite, but for even excessive values of n is only moderately great.

It is notable how close to the velocity of light it is necessary to get before this effect becomes prominent; the instability must be expected to arrive sharply whenever the velocity of light is from any cause, *e.g.* perturbation or collision, attained by any moving electrically charged part of an atom. Assuming a Maxwell distribution of velocities and an average speed, for the internal atomic motions, it may be possible (as J. J. Thomson suggested in NATURE of April 30, p. 601) to calculate what percentage of a given number of atoms reach the unstable stage by this means, and so to make a theoretical estimate of the amount of radio-activity to be expected, and of the life of an atom. But the slight constant radiation-loss seems competent to bring about instability and decay irrespective of collisions, and therefore independently of any Maxwell-Boltzmann law. OLIVER J. LODGE.

PHOTOGRAPHS OF SNOW CRYSTALS.

AT the beginning of last year (vol. lxv. p. 234) we summarised a paper contributed by Mr. W. A. Bentley to the U.S. *Monthly Weather Review* upon his photomicrographs of snow crystals. Mr. Bentley has made a study of the forms of snow crystals for more than twenty years, and has obtained a most valuable collection of photomicrographs taken with the object of discovering the connection between characteristic forms and particular meteorological conditions. During the winter of 1901–1902 a systematic record was secured by Mr. Bentley of a number of snow storms, and several good photomicrographs from each storm were obtained by him, more than two hundred pictures being added to his collection. The annual summary of the *Monthly Weather Review* for 1902 (vol. xxx. No. 13), which has just been received, contains reproductions of these photomicrographs and a paper by Mr. Bentley describing the various types of structure and the meteorological conditions prevailing at the time when they were produced. The paper contains an instructive account of snow crystals, and an analysis of the results of the studies carried on during the winter of 1901–1902. The interest of the pictures lies not merely in the fact that many of the forms photographed are very remarkable, but that they also represent, so far as possible, stages in the life-history of snowstorms, several pictures having been obtained of each storm, while at the same time a record was kept of the conditions of temperature, pressure, wind, cloud and position of storm from which the snow fell.

We print a few extracts from the contribution and reproduce several photomicrographs of exceptional interest from those given in the *Monthly Weather Review*.

In general the data tend to confirm further the conclusions of all observers, that a more or less intimate connection exists between form and size of nuclei, and the altitude and temperature of the air in which the crystals form. There can be no longer any doubt that there is a general law of distribution of the various types of crystals throughout the different portions of a great storm. On this point the data secured, both by direct observation and by a study of the weather maps, are much more complete and satisfactory than has hitherto been published. This aspect of our study received special consideration, because it was thought to be most important.

Snowstorms often cover a region of vast extent; crystallisation is going on within them over nearly the whole area, and therefore in regions that differ greatly among themselves as to temperature, humidity, air density, electrical conditions, &c. Moreover, the kind, number, dimensions, altitude and density of the clouds within those various regions differ so greatly one from another that the snow crystals emanating from each region furnish us rare opportunities for observing and studying the effects of each of these various conditions upon the forms.

The results arrived at by a study of the data secured during the four winters of 1898–99 to 1901–2, inclusive, in regard to the relative frequency of occurrences of the various types and the apparent connection between size and form and the air temperatures, agree in general with the results arrived at by many other meteorologists and observers, both in Europe and America, as set forth in the work "Schneekrystalle," by Dr. G. Hellmann, Berlin, 1893.

Doubtless the actual connection between forms and sizes of snow crystals and the temperature and density of the air is much more intimate than our present knowledge would indicate, because our studies are based on air temperatures at the earth's surface, instead of in the cloud strata where the snow crystals form. The temperature may often be mild at the earth's surface when the crystals are developing at high altitudes where the cold is intense, and such crystals should be classed with those deposited during extreme cold.

Structure of Snow Crystals.—The beautiful details, the lines, rods, flowery geometrical tracings and delicate symmetrically arranged shadings to be found within the interior portions of most of the more compact tabular crystals, and

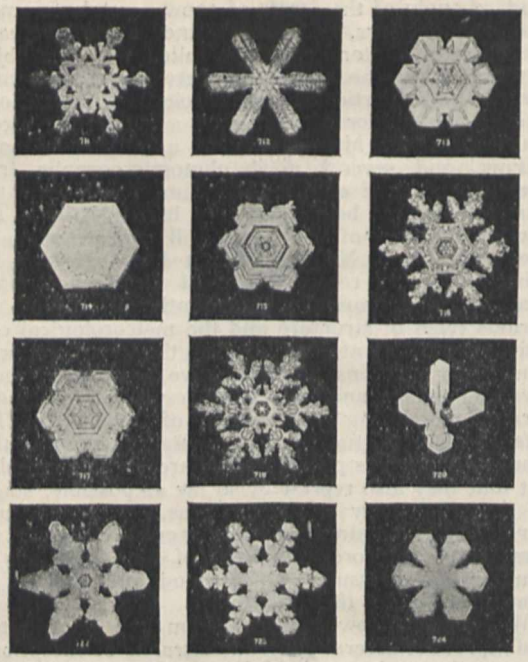

FIG. 1.—Nos. 711–724.

in less degree within the more open ones, have attracted the attention of nearly all observers who have studied snow crystals. That these interior details more or less perfectly outline preexisting forms must have been early recognised, yet the knowledge as to what they actually were remained long in obscurity, and a complete explanation of all of them is yet to be found. The investigations of Drs. Nordenskiold and G. Hellmann enable us to form a general conception as to their true character. These observers discovered that many of the lines, rods, and other configurations within the crystals, that add so much to the beauty of the forms, and which are so plainly revealed in the photomicrographs, are due to minute inclusions of air. This included air prevents a complete joining of the water molecules; the walls of the resultant air tubes cause the absorption and refraction of a part of the rays of light entering the crystal; hence, those portions appear darker by transmitted light than do the other portions. The softer and broader interior shadings may perhaps also be due, in whole or part, to the same cause, but if so, the corresponding inclusions of air must necessarily be much more attenuated and more widely diffused than in the former cases. We can only conjecture as to the manner in which these minute air tubes and blisters are formed. It may well be that some of them are the result of a sudden and simultaneous rushing together of water molecules around the crystal from all sides. This might result in the formation of closely contiguous parallel ledges, or laterally projecting outgrowths that are separated from each other during the initial impact by a narrow groove, or air space, but are soon bridged over by subsequent growth. Similar contiguous parallel growths occur frequently around the angles of very short columnar forms, and lend plausibility to this theory. Air spaces also exist within columnar forms, as noted by Hellmann and Nordenskiold. They seem to occur within such forms as hollow cup-like extensions, projecting perpendicularly within them from each of the ends of the crystals.

Modifications of Forms of Snow Crystals.—By close study of the photomicrographs, we find that the most common form outlined within the nuclear portions of the crystals is a simple star of six rays, a solid hexagon, and a circle. The subsequent additions assume a bewildering variety of shapes, each of which usually differs widely from the one that preceded it, and from the primitive nuclear form at its centre. Bearing in mind, however, the tendency of the crystals evolved within the upper clouds toward solidity, and the tendency of those from the lower clouds to form more branching open crystals, our task of deciphering the

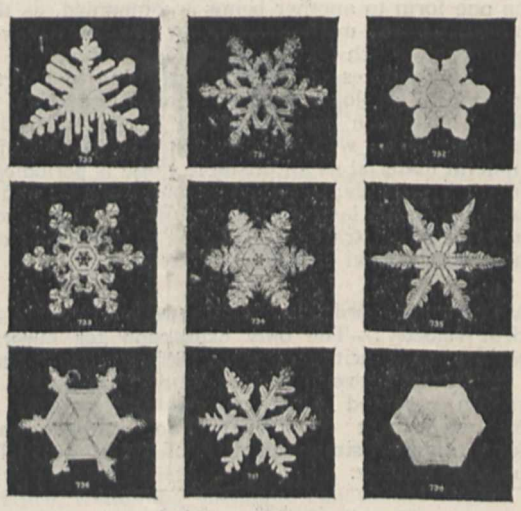

FIG. 2.—Nos. 730–738.

hieroglyphics, and of tracing thereby the probable flights of each individual crystal within the clouds, becomes much easier than might be anticipated.

Taking photomicrograph No. 821 as an example, we can picture with some certainty its various flights within the clouds during each stage of its growth. Star-shaped at birth, it was probably carried upward by ascending air currents, and at some upper level assumed the solid hexagonal form that we see outlined around the star-shaped nucleus. Having now become heavier, it probably descended, and acquired further growth at some lower level, such as that wherein it had its birth.

Modifications of Forms due to other Causes.—As it is generally conceded that winds play an important part in modifying the forms of snow crystals, let us consider the probable manner in which they operate to accomplish this.

Aside from causing modifications by wafting the crystals upward and downward within the clouds to regions varying in temperature, humidity, density, &c., as previously noted, the winds probably cause modifications in other ways. Violent winds may prevent a perfect and orderly joining of the aqueous molecules, causing imperfections in the forms, or perhaps amorphous, granular aggregations.

Again, they may waft greater quantities of water molecules to one or more portions of a growing crystal, causing abnormal growth to take place around such portions.

More important still, violent winds often cause fractures

to occur, especially as regards the branching forms, and whenever, as must often happen, subsequent growth takes place around and upon such broken crystals, irregular, unsymmetrical forms result. Doubtless, we may attribute the origin of some of the odd oblong crystals to the fact that crystallisation sometimes takes place around and upon a long broken branch, or other long portion detached by fracture from some preexisting crystal. Other odd forms seem to owe their abnormal character to design rather than accident. Columnar forms and, in a less degree, small solid tabular forms, being relatively so much heavier and more compact than stellar and similar branching forms, are much less likely than these to be wafted about and to receive modifications due to wind action.

Among the other causes of modification of forms, we must mention the close proximity of two or more crystals during one or more stages of their growth. This close proximity while developing would probably cause a greater growth of those portions of each contiguous crystal that lie farthest away from the crystal closely adjoining, and thus perfect symmetry would be impaired.

Considerable modifications of form are frequently due to the aggregation upon the crystals of amorphous or granular material, contributed by relatively coarse cloud spherules, particles of mist, or minute rain drops. Frail light, branching stellar and other forms are often rendered coarse and

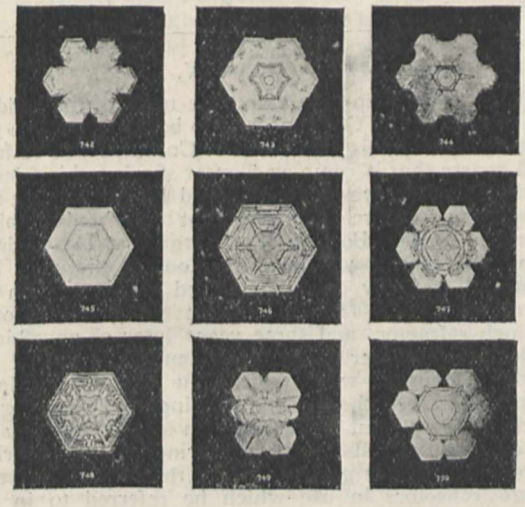

FIG. 3.—Nos. 742-750.

heavy by such additions taking place around and upon every angle of the crystals, so that they fall quickly to the earth.

Perfect crystals are frequently covered over and lines of beauty obliterated by such granular coatings. Granulation often proceeds to such a degree, and the true crystals are so deeply coated over and imbedded within it, that the character of the nucleus does not reveal itself, except under the closest examination. Such heavy granular covered crystals possess great interest for many reasons; they show when the character of the snow is due to the aggregation of relatively coarse cloud particles, or minute rain drops, and not to the aggregation of the much smaller molecules of water, presumably floating freely about between them. They also offer a complete explanation of the formation and growth of the very large rain drops that often fall from thunder-clouds and other rainstorms, if we accept the conclusion that such large drops result from the melting, or merging together, of one or more of the large granular crystals. For many reasons (among which we mention the almost invariable presence of low cloud strata when granulation occurs, and the aggregation occurring on perfect crystals, while these are presumably within the low clouds, rather than the occurrence of such aggregations as a distinct identity by itself) we are led to infer that, as a rule, the heavy granular covered crystals are peculiarly a product of the lower or intermediate cloud strata.

Chronological List of Snowstorms and Photomicrographs.—We now pass to the analysis of the photomicrographs of individual snow crystals secured during the remarkably

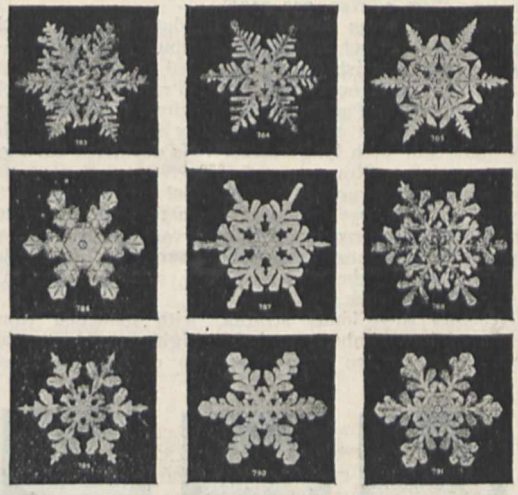

FIG. 4.—Nos. 783-791.

favourable winter of 1901-2. The number of individual crystals is very considerable, and the beautiful or odd and interesting ones form a large percentage of the whole number; many of them deserve special mention and prolonged close study. Considering them in chronological order, the snow forms of the blizzards of November, 1901, first demand our attention.

1901, *November* 26.—Eighteen different forms were photographed on this date, and among them two, Nos. 716 and 718 (Fig. 1), are very choice and beautiful. These exhibit a rather unusual and notable peculiarity, viz. a plain or delicately lined nucleus contrasted with a brecciated, boldly designed external portion; the latter approaching granulation, as though the nuclear portion was formed in clouds that were less dense and humid than those in which the outline portions were added. No. 712 is a fine example of the star-shaped form of crystal, exhibiting an extreme and slender development of the six primary rays without any corresponding development of the secondary rays. Many of the branching forms of this date were observed to be broken, as though by the action of violent winds.

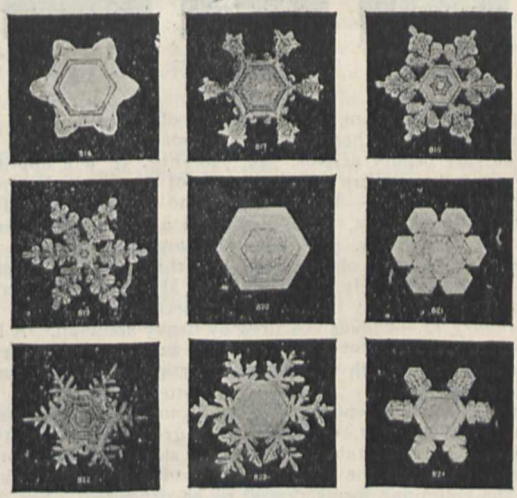

FIG 5.—Nos. 816-824.

November 27.—Continuation of the same storm. Crystal types small, granular, and irregular, succeeded later by medium-sized, rather compact crystalline tabular forms and

a few doublets. Nos. 722 and 723 are charming patterns in snow architecture.

November 30.—Clouds rather thin stratus and nimbus. Crystal types wholly tabular of both open and stellate structure (Fig. 2, Nos. 730–737).

Among the seven forms of this date we find much to admire in the perfect beauty and symmetry of Nos. 731–734. The beautiful starfish design exhibited by No. 735 is somewhat rare. It is noteworthy that Prof. S. Squinabol, of the University of Padua, made drawings of a snow crystal found in Genoa in 1887 that closely resembles this latter one. The star with long slender rays deposited during this same storm, on November 26 (see No. 712), also closely resembles one figured by Squinabol in his work "La Navigata." No. 737 is another form that closely resembles some of those secured by other observers; it is very similar to some of the photomicrographs secured by Dr. Neuhaus, of Berlin, during the winter of 1893, and published in Dr. G. Hellmann's work.

December 4.—Clouds stratus, with detached running masses of low nimbus; probably high cirro-stratus above these. The western portion of this cold southern storm

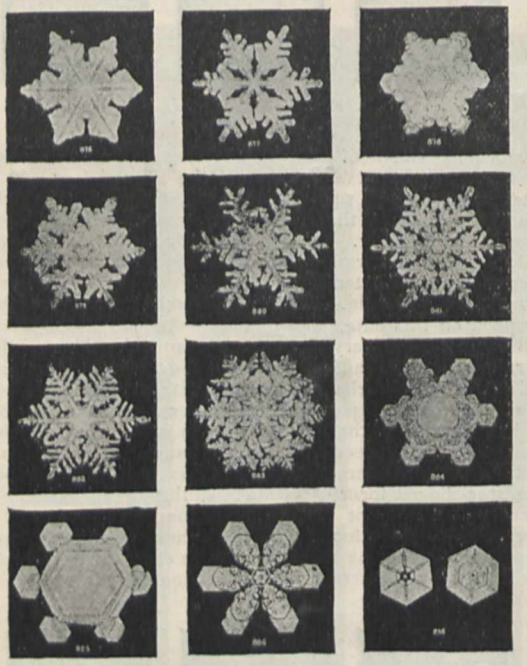

FIG. 6.—Nos. 876–888.

furnished a great number of forms of snow crystals that were in general rather small and compact.

The rare beauty of Nos. 745, 748 (Fig. 3) will appeal to all; crystallographers will find much of interest in No. 749.

1902, *January* 5.—The clouds of the western edge of the storm of January 5, 1902, furnished a large and splendid set of forms. Nos. 783, 785, 786, and 788 (Fig. 4) are exquisite examples of the frail, branching type of crystals. No. 785 is so rarely beautiful that Mr. Bentley describes it as the peer of any in his whole collection.

January 12.—Clouds obscured by heavy snowfall. A long series of magnificent snow crystals was secured from the clouds of the south-west-central portion of the storm or blizzard of January 12 (see Nos. 816–824, Fig. 5). The snow, as usual whenever it comes from the central-western portion of a storm, consisted of a great variety of types both columnar and tabular, but as the storm's central portion passed farther to the east, during the afternoon of January 12, the columnar forms ceased to be deposited. Nos. 818, 821 and 822 possess much beauty of design and perfection of form.

February 8.—Clouds stratus and nimbus; probably high cirro-stratus superimposed above them. A continuation of the storm of February 7, and its increase in rigour furnished more forms than were ever before secured by Mr. Bentley from any one storm. The beautiful branching crystals, Nos. 881 and 883 (Fig. 6), portray, in general, the characters of the forms that successively replaced both the solid tabular and columnar forms, as the western edge of the storm came nearer. No. 884 exhibits a most interesting phase of crystallic evolution; it is composed of four contiguous points, or rather portions, and two somewhat stunted portions, also similar to each other, but differing widely from the other four. No. 885 shows two overlapping additions to two of the points, thus rendering it of more than usual interest, and presenting us with another seemingly unsolvable problem in crystallography.

In concluding this mention of individual forms, it is worthy of note that, as during previous winters, occasionally single individual crystals, and more rarely larger numbers of such, produced during the storms of this winter, resembled closely, in outline or interior details, or oddity, one or more of the individual forms found among the snows of previous winters. The recurrence of similar types, after perhaps long intervals of time have elapsed, is a phenomenon of great interest.

In conclusion, it may be worth noting that by the addition of more than 200 plates during the past winter, the number of individual photomicrographs of crystals in Mr. Bentley's collection is brought up to somewhat more than 1000, no two of which are alike. This completes also his seventeenth year of photographic work among the snow crystals.

DR. A. A. COMMON, F.R.S.

IT was with deep regret that the news of the sudden death of Dr. Common had to be announced in the last number of this Journal. Dr. Common was so hale and hearty that it came as a great shock to his friends to find that he was no more, and his loss is felt not only by a great circle of friends, but by the astronomical world at large. Born in 1841, August 7, Dr. Andrew Ainslie Common was by profession an engineer, but quite at an early date he turned his attention to astronomy. In 1874 he became the possessor of a 5½-inch refractor, and three years later of an 18-inch reflector by Calver. It was evidently the use of the latter instrument which sowed the seed for his later important researches in the making and silvering of both large and small mirrors. An idea of his remarkable energy and success in the grinding and silvering of mirrors can be gathered from the following list of large reflectors in use which he referred to in his presidential address to Section A (Department of Astronomy) of the British Association in 1900. This list only referred to reflectors of 2ft. 6in. and upwards, and out of the nine given five were from his own workshop.

Reflectors of 2 ft. 6 in. and upwards.

	ft.	in.
Lord Rosse	6	0
Dr. Common	5	0
Melbourne	4	0
Paris	4	0
Meudon	3	3
Solar Physics Observatory (Common) ...	3	0
Crossley (Lick; Common)	3	0
Greenwich (Common)	2	6
Solar Physics Observatory (Common) ...	2	6

His knowledge of engineering was a valuable adjunct in the designing and construction of the mountings for his large mirrors. Dr. Common paid great attention to this latter question, for on it depended to a very great extent their efficiency and utilisation. He eliminated the "tube" by substituting a light framework of iron which reduced air currents to a minimum; adopted a new method to prevent the mirror being strained; mounted large mirrors equatorially by the ingenious device of reducing the friction of the moving parts by floating them in mercury; designed

and used successfully a slipping plate for use in the principal focus for photographic and visual purposes.

Not only was his time chiefly devoted to the construction of these astronomical instruments, but he turned them to great advantage by showing what could be done with them. Among the most noteworthy of these attainments was the magnificent photograph of the nebula of Orion which he secured in 1883, and for which he won the gold medal of the Royal Astronomical Society. Nebulæ, star clusters, &c., all came under his keen eye, and his researches not only demonstrated the cumulative effect of the photographic film, but showed that a new field of astronomical work was dawning by the employment of reflectors for long exposure photography.

More recently Dr. Common, among other things, turned his attention to the improvements in telescopic gun sights, and in this direction his loss will be keenly felt. He became a fellow of the Royal Astronomical Society in 1876, received the gold medal in 1884, and was president in 1895–96. He was elected a fellow of the Royal Society in 1885, and was an honorary LL.D. of St. Andrews.

Jovial, good-hearted, good-natured, and generous beyond degree in distributing his mirrors to those who would use them, all his friends join with the widow, son and three daughters whom he has left behind in mourning the loss of a personal friend.

WILLIAM J. S. LOCKYER.

PROF. C. A. BJERKNES.

IN NATURE of May 28 mention was made of the death of Prof. C. A. Bjerknes, of the University of Christiania, at the age of seventy-eight.

Though occupying the chair of pure mathematics, it was to applied mathematics, and especially to hydrodynamics, that Bjerknes devoted the greater part of his attention and study. He studied mathematics at the University of Göttingen early in the "fifties," his teachers including Riemann, who lectured on Abelian functions to a class of three only—Schering, Bjerknes and Dedekind—presumably between 1851, when Riemann obtained the doctorate, and 1859, when he was appointed ordinary professor, also Lejeune Dirichlet, who lectured to Schering and Bjerknes in 1855–56, and who proposed to them the problem of the ellipsoid in a steady fluid current. Solutions were given by both Schering and Bjerknes, but it was not until 1873 that Bjerknes completed his work on the problem of the general motion of an ellipsoid in fluid.

Bjerknes was at an early date attracted by the problem of replacing action at a distance by action of an intervening medium, and he exhibited considerable originality in the energy with which he took up the advancement of a doctrine which at that time received little support. The discovery that a sphere could move through a perfect liquid without retardation having shown that the existence of an ether does not involve a violation of Newton's first law, Bjerknes set to work to investigate the forces acting between two spheres moving in liquid, and in particular he developed the notion of "pulsating" spheres, *i.e.* spheres fluctuating periodically in volume, finding that between such spheres attractions and repulsions exist, obeying the law of the inverse square, and their sense being dependent on whether the phases are the same or opposite. The discussion of all the terms entering into the expressions for the forces was not completed until a comparatively late date, and in the meanwhile dynamical theories of physical phenomena have developed in other quarters, and ethers differing in their properties from ordinary matter, and in particular from matter in a fluid state, have come into existence. But another interest was aroused in these hydrodynamical attractions and repulsions by the experimental verifications of the results of the theory which were successfully carried out by both Prof. C. A. Bjerknes and his son, and of which we hope to give a fuller account shortly. These experiments were commenced in 1875, using rough and ready methods, but the apparatus have been gradually improved, and a number of papers on the subject were published, chiefly in the period 1878–1880, by Bjerknes and Schiötz in the Christiania *Forhandlinger*.

Among Bjerknes's other writings we note the biographical notice "Niels Henrik Abel; tableau de sa vie et de son action scientifique," published at Paris in 1885. Prof. V. Bjerknes has for many years collaborated with his father, and the second volume of his "Vorlesungen nach C. A. Bjerknes' Theorie" only appeared quite recently.

G. H. BRYAN.

NOTES.

MR. BALFOUR has accepted the presidency of the British Association for the meeting to be held at Cambridge in 1904.

PROF. RAY LANKESTER has been elected a Foreign Associate of the National Academy of Sciences, Washington, and a member of the American Philosophical Society, Philadelphia.

WE learn from the Paris correspondent of the *Times* that a monument, which has been erected by public subscription to the memory of Pasteur, was unveiled at Chartres on Sunday. This memorial specially commemorates the services of the great bacteriologist to agriculture by his discovery of a specific for anthrax, which resulted from a long series of experiments undertaken at a local farm. The principal feature of the monument is a high relief, which represents Pasteur and his assistants at work. It is the design of Dr. Paul Richer, who, besides being a member of the Academy of Medicine, is a distinguished sculptor.

A REUTER message from Simonstown, dated June 9, states that the German Antarctic ship *Gauss* arrived there on Tuesday morning after a successful year's work in the South Polar regions. She will remain there for three weeks to refit, and will then sail for home. On sailing from Cape Town the *Gauss* called at Kerguelen Island, and landed a party, which reached the floating ice on February 14, 1902. The ship was ice-bound on February 22 in lat. 66½, long. 90. New land was discovered, which was named the Emperor William II. Land. This was covered with ice, with the exception of an inactive volcano. The expedition was ice-bound here for almost a year, and many scientific investigations were carried out during this period. The ship left the ice on April 8 and proceeded to Durban, passing Kerguelen Island, and calling at St. Paul and New Amsterdam Islands. The members of the expedition enjoyed good health, there being no case of sickness, accident, or death during the whole cruise. Prof. Drygalski speaks in the highest terms of the vessel's behaviour, both in the sea and in the ice.

THE Hanbury gold medal has this year been awarded to M. Eugène Collin, École de Pharmacie, Paris.

A TABLET placed on the wall of Coate House, near Swindon, Wilts, the birthplace of Richard Jefferies, was unveiled by Prof. N. Story Maskelyne on June 6.

THE Vega medal of the Stockholm Society of Anthropology and Geography has been awarded to Prof. von Richthofen, of Berlin.

A NEW serum department of the Jenner Institute, at Elstree, will be opened on July 3. Dr. George Dean is the bacteriologist in charge of the department.

AN expedition in charge of Dr. F. A. Cook, of Brooklyn, is, says *Science*, to explore Mount McKinley and other Alaskan mountains under the auspices of the Geographical Society of Philadelphia and the Arctic Club, of New York.

THE Geological Society has made the first award of the proceeds of the Daniel Pidgeon fund, founded by Mrs. Pidgeon in accordance with the testamentary directions of her husband, the late Mr. Daniel Pidgeon, to Dr. E. W. Skeats, of the Royal College of Science.

THE Brussels *Bulletin Commercial* states that the Municipal Council of Lorient has recently decided to organise an International Exhibition of industry, agriculture, maritime defence, and fine arts, to be held from July to October of this year.

IT is reported that a young Austrian doctor named Sachs has fallen a victim to his scientific zeal, having accidentally inoculated himself with plague, from the effects of which he died after a short illness. Such regrettable incidents will occur while scientific research is pursued, and cannot be avoided even by the greatest foresight. There is no likelihood that other cases will develop, as under good hygienic conditions plague is not particularly infectious from man to man, and European doctors and nurses tending the sick seldom contract the disease.

THE wide distribution of typhoid-infected blankets that had been used in South Africa is another "regrettable incident" of the campaign, though those who made use of manifestly soiled blankets without washing them cannot be held blameless. On moist fabrics it has been proved that the typhoid bacillus retains its vitality for many weeks or even months.

Science announces that Prof. Florian Cajori, professor of mathematics at Colorado College, has been appointed representative of the United States on the international committee of the Congress for the Study of the History of the Sciences, which will make arrangements for the next meeting of the Congress at Berlin in 1906.

AT a meeting of the German Chemical Society on June 4 the presentation of the Hofmann foundation gold medal was made to Sir William Ramsay and to Prof. Moissan, of Paris. This medal is to be awarded once in every five years to a foreigner for distinguished chemical research work. The medal awarded to Sir William Ramsay bears on the obverse the effigy of Hofmann and on the reverse the inscription "For distinguished work in the field of general chemistry, and particularly for the discovery of new ingredients of the air."

BY the death of M. Eugène Demarcay at the early age of fifty-one, French science has suffered a severe loss. Although his earlier work was in the field of organic chemistry, his name is best known in connection with his researches on the chemistry of the rare earths. The magnificent specimens of pure salts of neodidymium, praseodidymium, samarium and europium shown by him at the Paris Exhibition of 1900 were the result of years of work of the most painstaking and laborious kind in a field in which he was one of the pioneers, and in which the number of workers is still too few.

AN Engineering Conference in connection with the Institution of Civil Engineers will commence on June 16 when Mr. W. H. Maw will deliver the eleventh "James Forrest" lecture on "Some Unsolved Problems in Engineering." On June 17 Mr. J. C. Hawkshaw, president, will inaugurate the conference with a short address to all the sections. The sections with their chairmen are as follows:—(1) Railways, Sir Guilford Molesworth, K.C.I.E.; (2) harbours, docks, and canals, Sir Leader Williams; (3) machinery, Dr. Alexander B. W. Kennedy, F.R.S.; (4) mining and metallurgy, Mr. E. P. Martin; (5) shipbuilding, Sir John I. Thornycroft, F.R.S.; (6) waterworks, sewerage, and gasworks, Sir Alexander Binnie; (7) applications of electricity, Mr. Alexander Siemens.

A PRACTICAL demonstration of the great power of the Marconi Wireless Telegraph station at Poldhu was given by Prof. Fleming during his lecture at the Royal Institution last week. A large mast had been erected above the Institution, and a complete receiving station set up; messages were received from Mr. Marconi, signalling from Poldhu, and also from a transmitting station at University College. All the experiments passed off without the slightest hitch. Prof. Fleming, in speaking of the future prospects of wireless telegraphy, laid stress upon the fact that there was a large sphere of usefulness open to it which submarine cables and land telegraphs could not touch.

IN the House of Commons on Monday Mr. Austen Chamberlain, speaking on the vote for the telegraph Services, referred at some length to the relations between the Post Office and the Marconi Wireless Telegraph Co. He said that the Post Office had no desire to check the progress of wireless telegraphy, nor could they have done so had they wished, as their monopoly did not extend beyond the three-mile limit. The Marconi Co. had, however, asked for too much; in the first instance they asked to be given a permanent and exclusive right to work wireless telegraphy in this country, which he could not grant, especially after the Post Office's experience with the telephone system. He had, however, granted them a private wire to Poldhu on the ordinary terms as soon as they asked for it, but before undertaking to act as their agents for the collection of messages, as was done for the cable companies, the Post Office required that certain conditions should be fulfilled in order to safeguard the Admiralty, and also asked that their experts should be satisfied that the company were able to carry on their business and transmit messages across the Atlantic commercially. He was still waiting an answer to this request, which was made last March. This statement does not quite tally with the accounts which were published last February, and were allowed then to pass uncontradicted. In any case there seems no reason why the Marconi Company should be required to pass an examination set by the Post Office; if people wish to risk sending messages by wireless telegraphy to America, they ought to be allowed full facilities for doing so; the Post Office by taking in the messages need incur no responsibility, by refusing to take them in it renders itself open to the charge of obstructing progress.

REUTER'S Agency is informed that a large number of foreign Government and technical delegates will be present

at the International Fire Prevention Congress which is to be held in London next month. The congress has been convened by the British Fire Prevention Committee, and will work in six sections, the papers and discussions being in English, French, and German.

WE regret to record the death, on May 30, of Mr. Alfred Haviland, aged seventy-eight. He had for many years devoted attention to the geographical distribution of disease in Great Britain, more especially of cancer and heart disease, having published maps and a separate volume on the subject.

WE learn from a cutting from the *Brisbane Courier* that Dr. J. P. Thomson, the hon. secretary of the Royal Geographical Society of Australasia, has left Brisbane on a visit to America, Great Britain and the Continent. At a meeting prior to his departure Dr. Thomson was invested with the powers of a delegate from the Australasian Society to all kindred societies in the various centres he may visit.

THE death is announced of Prof. Deichmüller, extraordinary professor of astronomy at Bonn University. From the *Athenaeum* we learn that he was born on February 25, 1855, and not long after completing his nineteenth year took part in the German expedition to observe the transit of Venus at Tschifu in 1874. Ever since October, 1876, he had been attached to the Bonn Observatory, and had shown skill not only as an astronomical observer and calculator, but also as a mechanician. He took a prominent part in the teaching at the University, and was made extraordinary professor of astronomy in 1897.

AN account of the life and works of the late Prof. Willard Gibbs is given in the Yale *Alumni Weekly* for May 6. It contains a portrait of Prof. Gibbs, and a chronological record of his principal published papers, together with a list of some of his academic distinctions and of the societies of which he was a member. Besides the papers which have done most to make his name known, Prof. Gibbs made important contributions in the domain of physical optics, notably in connection with the electromagnetic theory, but it is only by an exhaustive study of the papers themselves that his work can be adequately appreciated.

M. DE FONVIELLE writes that at the end of April a balloon belonging to the German Aëronautical Society left Berlin in the morning and landed at Skjolkör, in Seeland, in the afternoon, having crossed the Baltic in nine hours. The balloon was subsequently destroyed by a spontaneous explosion, the result of an electric discharge. The balloon reached an altitude of 4000 metres, where a temperature of $-16°$ C. was registered. During the descent of the balloon the aëronauts observed crystals of snow falling in the car; the electricity generated by the formation of the snow had not had time to escape before the first impact with the earth, because the descent was very rapid. When the pilot took hold of the valve line an explosion occurred and ignited the gas of the balloon.

WE have received an advance copy of Merck's annual report for 1902 on advancements in pharmaceutical chemistry and therapeutics. It is a valuable and interesting summary of new preparations introduced for the treatment of disease, and should be in the hands of every medical man. It contains, in addition, notes upon many old remedies and the manner of prescribing them, together with a full bibliography.

IT is announced that Dr. Louis Martin, of the Pasteur Institute, Paris, has succeeded in preparing pastilles of an anti-diphtheritic serum for local treatment. The serum is an anti-microbic one obtained by the injection of dead diphtheria bacilli. These pastilles will not replace the injection of the serum, but will supplement the action of the latter, and during convalescence will remove contagion by destroying the diphtheria bacilli in the patient's throat.

MR. JONATHAN HUTCHINSON, F.R.S., has returned from his tour in India and Ceylon more convinced than ever of the correctness of his theory that leprosy is connected with the consumption of fish. In a letter to the *Times* (May 25) he states that there is no risk whatever from fresh or well-cured fish; the danger comes when decomposition commences. He points out that there is an excessive prevalence of leprosy among the Roman Catholic community in India, and suggests that the fast-day ordinances should be modified, also that the salt-tax should be abolished. The leprosy bacillus has never been found in fish, and Mr. Hutchinson does not explain how it is that fish becomes infective when stale.

MR. DAVID HOUSTON has examined bacteriologically a number of samples of Irish butter publicly exhibited, and concludes that a bacteriological examination will yield important information concerning the grade of any particular sample of butter. For example, one prize butter contained 260 spores of moulds per gram; the creamery was visited and the walls were found to be covered with a growth of mould. Another creamery sent a "preserved" sample and gained a prize. A specimen of the butter-milk taken from the churn was found to be crowded with putrefying and gas-forming bacteria, together with wild yeasts and moulds; a most undesirable state of things, and revealing why a "preserved" sample was exhibited.

IT has been stated by some authorities that the colon bacillus is normally present in the digestive tract of oysters. As this bacillus is undesirable in water used for drinking purposes, inasmuch as its presence may indicate the pollution of such water with sewage, it is not surprising that considerable interest has been aroused by its being reputed to be constantly present in the bodies of these molluscs. Mr. Caleb A. Fuller, of the Brown University, U.S.A., has endeavoured to throw fresh light on the subject by carrying out a systematic qualitative bacteriological examination of the digestive tract in the case of more than 2000 oysters. The specimens were taken from a bank which was free from any trace of pollution, and the colon bacillus was entirely absent from the adjacent sea-water. Sixteen different varieties of bacteria were isolated and examined, but not a single colon bacillus was discovered. This result would seem to indicate that oysters do *not* normally contain the *B. coli communis*, and that if it is found in their digestive tract, suspicion should fall on the breeding ground as having been exposed to pollution.

THE report of the Fernley Observatory, Southport, for the year 1902, shows that the work of this well-equipped establishment has been kept up to the usual high standard of efficiency. Mr. Baxendell does excellent work, not only in taking observations, but by instituting useful comparisons between various instruments and methods. The delicate records of the Halliwell self-registering rain-gauge give much satisfaction; this instrument recorded 641 hours of rain against 573 hours by another recording gauge. The comparison of the Campbell-Stokes and Jordan sunshine records gave only a difference of fifteen hours in the year in favour of the latter instrument, a much closer result in tabulating the records than some less careful observers might have reached. Several new tables have been added,

dealing with hourly results; one of these shows that the land and sea breezes are unusually marked at Southport, to an extent, the author remarks, of which meteorologists were not aware. The report contains the usual interesting comparison of climatological statistics with other health resorts.

THE Meteorological Office pilot chart for June shows that, as a result of the decision of the shipping companies to divert temporarily the steamer routes to the southward, there has been a great decrease in the number of ice reports from the southern extremity of the Newfoundland Bank. With the opening of the St. Lawrence season, however, reports from the northern part of the Bank are becoming more frequent. Another feature of the chart is an illustrated description of the violent storm of wind, rain and snow which, originating near Corsica, suddenly developed great energy on the evening of April 16, and starting off across north Italy, travelled through Austria and Poland to the Baltic and the Gulf of Bothnia.

THE twenty-second number of the pamphlet series issued by the West Indian Department of Agriculture forms part ii. of Mr. Maxwell-Lefroy's investigation of "The Scale Insects of the Lesser Antilles." It contains fifty pages of valuable illustrated information on a subject which is of the greatest importance to the colonists, as scale insects are becoming increasingly troublesome in some of the islands. The twenty-third pamphlet contains Mr. John Barclay's "Notes on Poultry in the West Indies." Hitherto the only information which the colonists had on the subject of poultry applied to countries well outside the tropics, but Mr. Barclay, of the Jamaica Agricultural Society, has for several years past devoted personal attention to the rearing of poultry in a tropical climate.

COMMANDER WHITEHOUSE, R.N., has, we learn from the *Times*, returned to England on sick leave from the survey of the southern portion of the Victoria Nyanza. With the recently inaugurated service of steamers round the lake the quickest route to the Tanganyika region will be by way of the Uganda Railway, and a project is on foot for opening a route from Lake Victoria to the north of Tanganyika to connect with the steamer on the last-named lake. Discoveries of gold are stated to have been made both in British and German territory along Lake Victoria, one being near the Lumbas Station of the Uganda Railway at mile 520, and the other in German territory to the east of Speke Gulf.

IN the course of a recent article published in the *Recueil de l'Institut botanique de Bruxelles*, Prof. Errera comes to the conclusion that it is not possible for organisms to exist of a size very appreciably smaller than those which can be observed with the highest powers of the microscope now in use. An estimation is made of the number of molecules of certain bodies, such as albuminoids, which are present in a bacterium of given size: the number is of such an order of magnitude that only a few molecules could be present in an organism having a diameter 0·01 μ, and thus a minimum limit to the possible size is obtained.

THE geology of Kalahandi State, in the Central Provinces of India, is described by Dr. T. L. Walker (*Mem.* Geol. Surv. India, vol. xxxiii. part iii.). The entire State is made up of unfossiliferous rocks, mainly crystalline schists, with occasional masses of laterite which cap the broad hills in the south-eastern part of the State. The occurrence of graphite, which may be of commercial importance, is noticed, and it is remarked that the graphite-bearing rocks may become diamond-bearing in places where they have been subjected to intense pressure. In sands from the streams near Bondesor, minute crystals, regarded as diamonds, have been detected.

ALTHOUGH several accounts of the cytological changes which accompany the formation of eggs in the Saprolegniaceæ have been published, the lack of agreement in details and conclusions made it desirable that further evidence should be obtained. This is forthcoming in the experiments and histological investigations which are recorded by Prof. B. M. Davis in the *Decennial Publications* of the University of Chicago. The experiments were conducted entirely with plants bearing oogonia only. A peculiar feature is the appearance of specialised masses of cytoplasm, the cœnocentra, round which the eggs are formed, and which influence the destiny of the nuclei.

A RECENT issue of *Psyche* contains the full report of a lecture by Mr. F. M. Webster on the "diffusion" of insects in North America. It is pointed out that this diffusion commenced far back in the Tertiary period, and attention is directed to the intimate connection between the insects of North America, northern Asia and Europe which existed at that epoch. Very remarkable is the fact that the modern Rhynchophora of North America agree more closely with their European Tertiary representatives than they do with those of their own country. All this indicates the probability of a former free intercourse between America and Asia, and perhaps also between America and Europe *viâ* the north-east. The lines of insect diffusion on the American continent are treated in some detail.

THE heredity of albinism forms the subject of a paper by Messrs. Castle and Allen published in the *Proceedings* of the American Academy. The experiments, which were made with mice, guineapigs, and rabbits, serve to show that albinism, at least in domesticated animals, is not, as often supposed, a sign of weakness and want of vigour. The important result is, however, the proof that albinism, as indicated by its disappearance for a generation and its subsequent reappearance under close breeding, is inherited in conformity with Mendel's law of heredity, and that, in the terminology of that law, it belongs to the category of recessive phenomena. For instance, in the case of mice, it has been demonstrated that the grey hybrids produced by crossing grey with white mice, when bred *inter se*, gave birth to grey and white offspring approximately in the Mendelian ratio of three to one.

IN the *Monthly Review* for June Sir Herbert Maxwell reviews the question of animal intelligence; that is to say, the psychology of animals other than man. Commencing with the declaration that he has nothing new to communicate, the author proceeds to observe that the problem resolves itself into three items. (1) Are animals born as automatons, and do they continue as such throughout life? (2) If they are conscious, are their consciousness and intelligence merely the physical products of certain changes which take place during development, and therefore spontaneous in the sense that the development of organic tissue is spontaneous? (3) Is the conscious intelligence esoteric, that is to say, due to the action of an external and superior mandate, or suggestion, acting upon a suitable physical receptacle? After relating a number of instances of animal behaviour bearing upon it, Sir Herbert considers it probable that the first question should be answered as follows, namely, that at birth animals are sentient and unconscious automatons, but that they are also provided with mental machinery ready to respond in a greater or less degree to

external impressions. In regard to the second question, evidence is adduced to show that, although the growth of the organ of consciousness may be considered spontaneous and congenital, yet that there are instances where the intelligence of individuals displays a forward movement which may have important effects upon the habits of the race. As regards the third question, the author observes that if it be unphilosophical to attribute to a certain species of moth a knowledge of vegetable physiology, "what is left but to speculate whether the First Cause be not also a Directing Power, with means of communicating his mandates to the humblest of his creatures?"

IN the current number of the *Bulletin of the American Mathematical Society*, Mr. E. B. Wilson reviews a very interesting work, Prof. G. Loria's "Ebene Curven," which ought to attract all classes of mathematicians. Besides giving an account (illustrated with numerous figures) of a large number of special plane curves which are of interest for historical or other reasons, Prof. Loria gives a summary of his memoir on panalgebraic curves. A panalgebraic curve is one for which x,y and dy/dx are connected by an algebraic equation; in this class are included a very large proportion of all plane curves which have hitherto been studied, and the fact that Prof. Loria has demonstrated a considerable number of geometrical properties common to them all is very interesting and remarkable.

MESSRS. DAWBARN AND WARD, LTD., have published a booklet by Mr. H. Snowden Ward entitled "Profitable Hobbies," containing much useful information upon manual work of various kinds which can be successfully performed by amateurs.

BY arrangement with Messrs. Kegan Paul, Trench, Trübner, and Co., Ltd., the Rationalist Press Association has published, through Messrs. Watts and Co., a sixpenny edition of J. Cotter Morison's "The Service of Man. An Essay towards the Religion of the Future."

IN the *Physikalische Zeitschrift*, No. 16, p. 457, Messrs. Elster and Geitel discuss the question of the cause of the electrical conductivity of the air in the neighbourhood of phosphorus undergoing slow oxidation. Experiments are described which indicate that the cloud rising from the surface of the phosphorus is not responsible in any way for the electrical conduction. It is also rendered probable by suitably devised experiments that the conductivity is really due to ionisation of the air in the neighbourhood of the phosphorus.

IN a recent investigation of the properties of colloidal solutions by Mr. H. Garrett, experiments on the viscosity of solutions of gelatin, silicic acid and albumin have been made which appear to throw considerable light on the nature of such systems. They behave like heterogeneous liquids composed of two solutions having a surface tension at the contact surfaces. At any given temperature the viscosity of these solutions is not constant, since this depends on the surface tension, and this again is a variable depending on the previous history of the solution.

A NEW refractory material, to which the name "Siloxicon" has been given, is now being manufactured on a large scale by the International Acheson Graphite Company at Niagara Falls. It contains silicon, oxygen and carbon, and is said to give most satisfactory results as a substitute for refractory clays, magnesia, lime and graphite in their application to high temperatures. The product is obtained by the action of carbon on silica at a temperature of 4500–5000° F. in the electric furnace, the quantity of carbon employed being insufficient for the complete reduction of the silica and its conversion into carbide. It is stated that in these circumstances compounds containing all three elements are obtained.

THE current number of the *Journal of Physical Chemistry* contains an interesting paper by Messrs. Miller and Kenrick on the subject of the identification of basic salts. The allocation of formulæ to basic salts is apt to be somewhat arbitrary, and there is no doubt that many of the "amorphous finely-divided precipitates" which have been endowed with formulæ and thus raised to the dignity of chemical individuality are nothing more than mixtures of different bodies in proportions dependent upon the conditions of preparation. The authors show that, at any rate for those precipitates the equilibrium of which with the mother-liquor is attained, the question of individuality can in many cases be solved by simple application of the phase rule. The considerations brought forward have been applied to establish the individuality of several basic salts which have been investigated.

IN the current number of the *Comptes rendus* there is an account, by M. P. Lemoult, of the preparation and properties of dibromoacetylene. Tribromoethylene, which is easily obtained in quantity by the action of sodium ethylate upon symmetrical tetra-bromoethanes, is heated with alcoholic potash in the absence of air, and the dibromoacetylene collected under water. The distillation has to be carried out in a current of nitrogen, as the substance is spontaneously inflammable in air. Dibromoacetylene cannot be distilled, even in a vacuum, and under certain conditions may explode violently. Bromine and iodine give rise to C_2Br_4 and $C_2Br_2I_2$ respectively, and cautious treatment of the ethereal solution with moist air or oxygen gives rise to oxalic and hydrobromic acids. The first action would appear to be the addition of oxygen resulting in the formation of oxalyl bromide, which is then acted upon by the water present in the usual manner.

WE have received from Mr. H. Kondo, director of the Taihoku Observatory, Formosa, valuable results of meteorological or rainfall observations made at fourteen stations in that island and in the Pescadores in the years 1896–1901, also a discussion of the observations (in Japanese) accompanied by diagrams showing very clearly the general characteristics of climate, tracks of typhoons, &c. We extract the following values for Keelung and Koshun, on the extreme north-east and south respectively; these are stations of the second order, but at the central observatory hourly observations are recorded. At Keelung the mean annual maximum temperature is 75°·7, minimum 66°·6; absolute maximum 94°·6 in July, minimum 37°·4 in February; mean annual rainfall about 150 inches. At Koshun the corresponding values are:—mean maximum 81°·7, minimum 71°·1; absolute maximum 92°·1 in July, minimum 49°·6 in February; mean annual rainfall about 92 inches.

THE additions to the Zoological Society's Gardens during the past week include two Grevy's Zebras (*Equus grevyi* ♂ ♀) from Southern Abyssinia, presented by Lieut.-Colonel J. L. Harrington, C.V.O.; two Leadbeater's Cockatoos (*Cacatua leadbeateri*) from Australia, presented by Lady Katherine Coke; two Eastern Sarus Cranes (*Grus antigone*), two Thurgi Terrapins (*Hardella thurgi*), a Batagur Water Tortoise (*Batagur baska*), twelve Long-fingered Frogs (*Rana hexadactyla*) from India, five Wall Lizards (*Lacerta muralis*, var. *melisselensis*) from St. Andrae, a Magpie (*Pica rustica albino*), British, deposited; two Common Camels (*Camelus dromedarius*, ♀ ♀) from the Soudan, purchased; a Red-fronted Lemur (*Lemur rufifrons*), two Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE SOUTH POLAR CAP OF MARS.—In an article published in No. 4, vol. xvii. of the *Astrophysical Journal*, Prof. Barnard details the results of his observations of the South Polar cap of Mars made at Lick during the close approaches of the planet in 1892 and 1894. He made a series of micrometrical measures of the cap during each opposition, and the figures obtained during 1892 are set out in a table which accompanies the article.

Whilst looking over these measures recently it occurred to Prof. Barnard that if they were plotted with respect to the summer solstice of the Martian southern hemisphere some instructive results might be obtained. This was done, and the two curves, which are reproduced, show that the cap at both oppositions followed the same law of decrease with remarkable fidelity.

Another important point observed was that the cap appeared to diminish for some time after the summer solstice, that is to say, the highest temperature was not reached until several weeks after the maximum of solar heat; this may have an important bearing when discussing the existence of a Martian atmosphere similar to the earth's atmosphere.

In May, 1894, the Polar cap covered an area of about 365,000 square miles, by the end of November it had completely disappeared, thus showing that the snow, if snow it be, is not of any very great depth.

One remarkable phenomenon observed was the appearance of a projection from the edge of the cap in the same position and at the same period during each opposition; this remained behind as a bright strip, and seems to indicate the existence of a mountain range which is probably high enough to remain permanently snow-capped.

Eight drawings of the cap during each opposition, and a drawing of the whole planet, accompany the article, and show the details of the outline of the cap very clearly.

THE HARVARD PHOTOGRAPHS OF THE ENTIRE SKY.—In *Circular* No. 71 of the Harvard College Observatory, Prof. E. C. Pickering gives a description of the photographs taken at Cambridge (Mass.) and Arequipa, which have been obtained so as to furnish a bi-monthly record of the entire sky down to stars of the twelfth magnitude. Each plate measures ten inches by eight, and covers a region of more than 30 degrees square; they have been obtained with two similar anastigmatic lenses of one inch aperture and thirteen inches focal length.

Prof. Pickering explains how useful these plates have already proved at Harvard in determining changes of variable stars, the times of the first appearances of Novæ, &c., and states that in order to allow astronomical science generally to participate in these benefits, it has been decided to make negative copies on glass of one series of fifty-five plates, and distribute them to all who desire them at a price below cost. The whole set of fifty-five may be obtained for 15·00 dollars, and selected sets of ten for 3·00 dollars; the balance of the cost is being paid from the "Advancement of Astronomical Science" fund of the Harvard Observatory. Should the demand justify the experiment a second set, the centres of which are near the corners of the first set, will be issued later.

Prof. Pickering gives a catalogue of the plates it is proposed to issue, giving full particulars of the regions they cover, the dates of exposure, &c., and in a set of "remarks" appended to the catalogue he gives details of any special object each plate contains.

THE ROYAL OBSERVATORY, GREENWICH.

THE Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, was read at the annual visitation on Saturday last. From the record of work done during the year covered by the report, we select a few notes referring to the state of some investigations of especial interest.

Longitude Operations.—The second stage of the redetermination of the Paris-Greenwich longitude was completed in the autumn of last year. As in the first stage carried out in the spring and referred to in the last report, observations were made simultaneously by two French and two English observers at adjacent stations. The observations of both the French and English observers were made in three groups of three, six, and three full nights (or their equivalents in half nights), the observers with their instruments being interchanged between the first and second and again between the second and third parts. In the determination made in the autumn the stands were also interchanged with the instruments.

The reduction of the observations made by the English observers is completed with the exception of slight corrections which may have to be made in a very few instances to the assumed right ascensions of the stars.

The determination made in the spring of last year gave for the difference of longitude between Cassini's meridian and that of the Greenwich transit-circle 9m. 20·974s., and for the difference of personal equation D−H=0·041s. The determination made in the autumn gave 9m. 20·909s. and the difference of personal equation D−H=0·049s. In the first series, if the level determination had been based entirely on observations of the striding levels, the result would have been 9m. 20·982s., and if entirely on the observations of nadirs 9m. 20·969s. In the second series the difference between the results from "striding levels" and "nadirs" was only 0·002s. In the first series the probable error of the difference of longitude determined from one full night's observations was ±0·040s., and in the second series only ±0·018s., giving for the probable error of the determination made in the spring ±0·0113s., and for that made in the autumn ±0·0047s. In each series there was a double interchange of observers, so that the probable error includes any change of personal equation between the first and third parts, and this would appear to account to some extent for the larger probable error found for the first series.

The International Geodetic Association, considering it desirable that a redetermination of the difference of longitude Potsdam-Greenwich should be made with their lately adopted Repsold registering micrometer, the longitude pavilion was placed at their disposal, and the Post Office authorities have given all the telegraphic facilities desired. Prof. Albrecht and Herr Obst installed their instruments in the last week in April, and the observations are now in progress.

Lunar Tables.—The need for improved tables of the moon has been emphasised during the past year by the discussion of the results of Greenwich observations in the last ten years, which was taken up primarily in connection with the delimitation of an Anglo-German boundary, and may perhaps be advantageously extended with a view to its use in the formation of improved tables of the moon. In the same connection Prof. Newcomb, who has devoted so much attention to the subject, has urged that a fresh comparison should be made between theory and the Greenwich meridian observations from 1750 to the present time. It is a question for consideration whether it would be practicable to carry out this work at the Royal Observatory in such a form as would facilitate the preparation of improved tables and materially advance the lunar theory.

Stellar Observations.—The progress made in the observation of the reference stars for the astrographic plates, for which more than 10,000 stars are to be observed three times above and twice below pole, has been very satisfactory.

The observations of these stars were commenced in 1897 and will be completed at the end of 1906. In 6·35 years 63½ per cent. of the observations have been secured, of which 11½ per cent. were contributed in the last year. From a comparison of the observations above and below pole for the stars from N.P.D. 0° to 5°, which have been completely observed, it appears that the probable error of a catalogue place (five observations) does not exceed ±0″·23 in R.A. or N.P.D.

As the photography for the Greenwich Zone (Dec.+64° to the Pole) has been completed, only a few photographs have been taken with the astrographic equatorial to replace some which appeared to be inferior to the general standard. Altogether 116 photographs were taken during the year; these include 16 plates for the Astrographic Chart, 21 for the Catalogue, 48 of Nova Persei, 11 of Comet *b* 1902, 6 of Comet *a* 1903, and 8 for the adjustments of the instrument.

The counting of the Chart plates has been continued during the year, and completed between Dec. 64° and Dec. 70°. A paper on the statistics of the stars between 65° and 70° N. Dec. was communicated to the Royal Astronomical Society in January, and printed in the *Monthly Notices*.

The 28-inch refractor has been used throughout the year for micrometric measurements of double stars. The total number of double stars measured during the year is 381; of these 192 have components less than 1″·0 apart, and 105 less than 0″·5.

Series of measures have been obtained of κ Pegasi, δ Equulei, 70 Ophiuchi, and ζ Herculis. Capella has been examined at every favourable opportunity, and observations of the position angle of the elongated image have been secured on eight occasions.

Solar Activity.—Shortly after the date of the last report a long period of almost complete solar quiescence set in; from 1902 June 5 to September 17 inclusive, a period of 105 days, the mean daily spotted area was less than a single unit (one millionth of the sun's visible hemisphere). An active period set in on September 18 and lasted until November 28, 72 days, the mean daily area being 164 millionths. The rest of the year 1902 was very quiet, the remaining 34 days showing a mean daily area of only 3. In the present year the sun has been much more active, and has been free from spots on only 14 days since January 1, as compared with about 100 in the same period of last year. The first of a fine series of spot-groups appeared on the east limb on 1903 March 21, and a succession of new groups has followed almost without intermission up to the date of this report. There can be no doubt, therefore, that the solar activity is very decidedly upon the increase.

Tables and diagrams showing the distribution of sun-spots in latitude and the areas of sun-spots and faculæ compared with magnetic diurnal ranges for the 29 years 1874 to 1902 have been prepared, and will be published in the *Monthly Notices* R.A.S. for May.

Magnetic Observations.—The principal results for the magnetic elements for 1902 are as follows:—

Mean declination	16° 22′·8 West.
Mean horizontal force	4·0134 (in British units).
	1·8505 (in Metric units).
Mean dip (with 3-inch needles)	67° 3′ 25″.

Meteorological Observations.—The mean temperature for the year 1902 was 49°·1, or 0°·4 below the average for the 50 years 1841–90.

The rainfall for the year ending 1903 April 30 was 23·68 inches, being 0·86 inch less than the average of 50 years. The number of rainy days was 172. The rainfall has been less than the average for each of the eight years from 1895 to 1902 inclusive, the total deficiency for the eight years ending 1902 December 31 amounting to 28·91 inches. For the four months 1903 January–April there has been an excess of 0·95 inch.

THEORY OF CYCLONES AND ANTICYCLONES.

PROF. F. H. BIGELOW contributes to the U.S. *Monthly Weather Review* for February a paper on the mechanism of counter-currents of different temperatures in cyclones and anticyclones. An outline theory of the structure of cyclones and anticyclones was described in the report of the Chief of the Weather Bureau for 1898–1899 (vol. ii). It was evident, however, that a more complete insight into the mechanism of motions in a fluid such as air under atmospheric conditions would be afforded by the construction of systems of isobars on at least three planes having different altitudes. For this purpose, the sea-level and the levels of 3500 and 10,000 feet were selected, and since December, 1902, daily reduced pressures for these planes have been received from the regular observing stations of the United States and Canada, and charts have been constructed for them. The approximate gradients needed for a preliminary consideration of the subject have thus been obtained, and the general results of the investigation are stated by Prof. Bigelow as follows:—

(1) The cyclone is not formed from the energy of the latent heat of condensation, however much this may strengthen its intensity; it is not an eddy in the eastward drift; but it is caused by the counterflow and overflow of currents of different temperatures. Ferrel's canal theory of the general circulation is not sustained by the observations, nor is his theory of local cyclones and anticyclones tenable. There are difficulties with regard to the German vortex theory, but this is nearer the truth than the Ferrel vortex. The structure in nature is actually more complex than has been admitted in these theoretical discussions, but it doubtless can be worked out successfully along the lines herein indicated. (2) Regarding the relation of the upper level isobars to practical forecasting, it is noted as the result of the examination of charts that (*a*) the direction of the advance of the centre of the low pressure is controlled by the upper strata, and its track for the following twenty-four hours is usually indicated by the position of the 10,000-foot level isobars; (*b*) the velocity of the daily motion is also dependent upon and is shown by the density of these high level isobars; (*c*) the penetrating power of the cyclone is safely inferred from an inspection of the three maps of isobars of the same date; (*d*) there is decided evidence that areas of precipitation occur where the 3500-foot isobars and the 10,000-foot isobars cross each other at an angle in the neighbourhood of 90°; (*e*) there have been several cases in which the formation of a new cyclone has been first distinctly shown on the upper system of isobars before penetrating to the surface or making itself evident at the sea level. (3) It is expected that by completing our discussion of the temperature gradients between the surface and the higher levels we shall be able to secure daily isotherms as well as daily isobars on the upper planes, and this will tend to strengthen any further examination of these important problems. A suitable report will be prepared in which the data now coming into our possession will be subjected to a mathematical analysis and discussion.

ATMOSPHERIC VARIATIONS.

FROM the results of recent researches solar prominences seem to be playing a most important part, not only in the mechanism of the solar atmosphere, but in the variations of our own. Any investigation, therefore, that gives us new ideas or corroborates the old is most useful and valuable. In a previous number of this Journal (vol. lxvii. p. 569, April) an account was given of the results obtained from a research on the distribution of solar prominences as regards latitude. The prominence circulation thus disclosed that there was practically a law at work which the centres of prominence action followed, and this law, deduced from observations extending over the longest period available (1872–1901), was found to be in good agreement with that first suggested by Prof. Ricco in 1891 (*Mem. d. Soc. degli Spettr.*, vol. xx. p. 135). Prof. Bigelow has also been studying the question of prominence, facula and spot circulation, and in a recent number of the *Monthly Weather Review* (vol. xxxi. No. 1, p. 9) has stated his results. The method he adopted was somewhat different from the one first mentioned above, for the prominence circulation determined by him has been deduced by finding the mean variation of the prominence distribution resulting from coupling up together the values for those years which he considers are similar in relation to the eleven-year sun-spot cycle. Anyone familiar with this cycle knows the difficulty this involves, because it is only the mean length of the sun-spot period that is eleven years. Further, the epochs of maxima do not follow those of the minima at constant intervals, but vary from a little more than three to five years. In spite, however, of these probable sources of error, Prof. Bigelow deduces a circulation not very different from the one mentioned above, so that all the three computations and deductions show that there is a very definite movement in latitude and change in percentage frequency of occurrence from year to year.

A most interesting and important contribution, by Prof. T. H. Davis, to our knowledge of the fluctuation of the annual wind resultants, and indirectly to our knowledge of the movements of cyclones and anticyclones, appeared in one of the recent numbers of the *Monthly Weather Review* (vol. xxx. No. 11, p. 519). The investigation was restricted chiefly to stations included in the meteorological services of the United States and Canada, and the period discussed was the ten years 1891–1900. The results of the research

are best seen by consulting the map accompanying the paper, on which all the mean wind directions for each year and for each station are plotted.

Most interesting curves of wind resultants at Key West, Bermuda, Mt. Washington, and Pike's Peak are reproduced. Prof. Davis concludes by saying:—"The remarkable relations revealed by these tables and charts show that the natural relations of the winds are complex and still obscure. I see no indication of a sun-spot nor of a lunar influence. To what natural laws or combination of laws are we to attribute these variations in the annual resultants?" Perhaps, as a suggestion, Prof. Davis might correlate the variations of the wind directions in the southern stations with the barometric changes from year to year, which latter have recently been shown to be nearly identical with those in South America, and the inverse of those in the regions about the Indian Ocean and Australia.

In connection with the preceding paragraph, the paper by Prof. K. Kassner, on "Sonnenflecken, Depressionen der Zugstrasse V^b und Niederschläge" (*Annalen der Hydrographie und Maritimen Météorologie*, March) is of great interest. The author has analysed the variations in the yearly number of barometric minima which pass along this cyclone track, as specified by van Bebber, for the long period 1874 to 1901. He shows that the variations are in general agreement with an inverted sun-spot curve, that is, that there is a greater number of these low pressure areas at sun-spot minima than at the maxima. There are, however, several outstanding minor variations of shorter period.

A CAMERA FOR NATURALISTS.

WE have recently had an opportunity of inspecting one of the "Birdland" cameras made by Messrs. Sanders and Crowhurst, of 71 Shaftesbury Avenue, to the design of Mr. Oliver G. Pike. Mr. Pike is well known as a specialist in the photography of birds and all that pertains to them, and so far as we, who are not specialists in this matter, are able to judge, the camera that he has designed is excellently adapted for the use of naturalists. Certainly no pains have been spared on the part of the makers to carry out Mr. Pike's ideas in a serviceable and practical way. The lens is a Goerz double anastigmat of 7 inches focal length, and by opening the front of the camera and drawing the lens forward, a change that is effected in a few seconds, the back combination may be used alone.

The range of focusing is sufficient to photograph objects within four or five feet even when the single combination is used, and the power that this provides in conjunction with the lens of twelve or thirteen inches focal length in getting large images will be appreciated by anyone who has attempted the photography of small animals. Focusing scales are affixed both for the complete lens and the single combination, though these would probably be rarely used, as the finder is a reflex arrangement that gives a full-size view of the image that falls upon the plate when the shutter is operated. An important point with regard to the finder is that its image can be seen when viewed from above, as usual, and also by looking horizontally when the camera is level with the eye. A mirror in the hood effects this desirable convenience. The shutter is the focal plane Anschutz, but with a device made specially by Messrs. Sanders and Crowhurst for linking it with the mirror within the camera that reflects the image upwards on to the finder screen. One release removes the mirror and operates the shutter, all the movements taking place smoothly and practically noiselessly. The camera is covered with a dull green leather, and all metal parts are bronzed, so that it forms an inconspicuous object in the ordinary surroundings of the country.

ENTOMOLOGY AT THE CAPE.[1]

THE Cape has been described as the most magnificent natural museum of insect pests and parasitic diseases which the world possesses, and the report of Mr. Lounsbery for 1901 shows that, despite the dislocation induced by the war, he is making good use of his opportunities. The various reports show clearly the directions economic entomology is now taking—the introduction of parasitic species which prey upon the pests, particularly of ladybirds feeding upon aphis and scale—fumigation of infested plants with hydrocyanic acid or carbon bisulphide—and the compounding of different sorts of spraying mixtures. Mr. Lounsbery gives accounts of several attempts at the introduction of exotic ladybirds from California to keep mealybug, scale and American blight in check, though none of them have yet become established, as has, however, been successfully achieved with the Vedalia, which keeps *Icerya purchasi* in check. Various recipes for making paraffin emulsions are given; considering the efficacy of paraffin as an insecticide, and the difficulty that is always experienced in keeping it emulsified, it is strange that more trial is not made of the method devised by Mr. H. H. Cousins of increasing the specific gravity of the paraffin by dissolving naphthalene in it. Another section of economic entomology treated in this report is the investigation of a cattle tick which serves as an intermediary host for a parasite causing "heart water," a disease mainly affecting sheep and goats, and of another tick-propagated disease known as malignant jaundice of dogs.

One interesting application of modern methods which may be found here reported is the fumigation with hydrocyanic acid of gaols, asylums, and kindred public buildings to free them of the insect vermin which are so terribly abundant in South Africa.

[1] Cape of Good Hope Report of the Government Entomologist for 1901. Pp. 103. (Cape Town, 1902.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. A. C. Seward, F.R.S., has been reappointed University lecturer in botany. The University lectureship in midwifery is vacant by the resignation of Mr. Stabb. Candidates are to make application to the Vice-Chancellor before October 20. Mr. L. Doncaster, King's, has been appointed assistant to the superintendent of the museum of zoology.

The University College of South Wales and Monmouthshire, Cardiff, is proposed for adoption as an institution affiliated to the University of Cambridge.

Dr. Humphry, Dr. S. West, and Dr. W. Hale White have been appointed examiners in medicine; Dr. Herman and Dr. Handfield Jones examiners in midwifery; and Mr. Clinton Dent, Mr. E. Ward, and Mr. E. Owen examiners in surgery—for the third M.B. examination. Mr. F. C. Parsons, St. Thomas's Hospital, London, has been appointed an examiner in human anatomy. Mr. A. E. Shipley has been reappointed University member of the council of the Marine Biological Association.

A CHAIR of agricultural botany has been established at the University of Rennes, and M. Daniel has been elected the first professor.

THE late Alderman Benjamin Robinson, chemical manufacturer, bequeathed 500*l*. for scholarships in connection with the Royal Salford Technical Institute.

DR. J. J. R. MACLEOD, assistant demonstrator of physiology at the London Hospital, has been appointed professor of physiology at the Western Reserve University, Cleveland, Ohio.

DR. JOHN RYAN has been appointed principal of the Paddington Technical Institute of the London County Council. Dr. Ryan was formerly professor of engineering at University College, Nottingham, and at University College, Bristol, and has for the past three years held the post of principal of the Woolwich Polytechnic.

THE Edinburgh summer meeting, which was instituted in 1886 and held annually until 1899, is now to be resumed, and the course will extend from August 3 to 29. The meeting will be directed by Prof. Patrick Geddes, and will deal this year especially with a study of Edinburgh and its region. The requirements of Scottish and English teachers in nature-study will receive prominent attention, and a series of excursions to various places of interest will be held. Sir John Murray, Prof. J. Arthur Thomson, and

Mr. J. G. Goodchild are assisting in various departments. Communications should be addressed to the secretary at the Outlook Tower, Edinburgh.

A SUMMER meeting of university extension students will be held in Oxford in August, the first part being from August 1 to August 13, and the second from August 13 to August 24. The inaugural address will be delivered on Saturday, August 1, at 8.30 p.m., by the United States Ambassador. The programme of lectures is grouped in five sections, one of which is natural science. The list of lecturers includes the names of Dr. C. W. Kimmins, Mr. Michael Sadler, and Prof. Sims Woodhead. Conferences have been arranged on "The Education Act of 1902 and University Extension," chairman, Sir William Anson, M.P.; "Free Libraries and Popular Education," chairman, Lord Goschen, F.R.S.; and "Science in its Relation to Industry," chairman, Sir Philip Magnus.

THE President of the Board of Education has appointed Dr. H. F. Heath, Academic Registrar of the University of London, to the post of director of special inquiries and reports rendered vacant by Mr. Sadler's resignation on May 9. As the papers describing the circumstances which led Mr. Sadler to resign an office filled by him with such success since 1895, when it was created, have not yet been laid before Parliament, the appointment of a new director was unexpected, and will be received with surprise by the educational world. For eight years Mr. Sadler has been engaged in collecting materials for the study of educational systems and methods, and the information he has rendered available in his eleven volumes of special reports has been of the greatest assistance to students of educational science. But scientific method and thoroughness meet with little encouragement in this country, and though everyone seriously interested in education recognises the value of Mr. Sadler's work and understands its formative influence, it is evident that to the official mind the exigencies of the moment are of more consequence than scientific knowledge. It is to be hoped that the outcome of the affair will be to place the Special Inquiries Office on a firmer footing, and that the new director will be given increased facilities for the continued efficiency of the work carried on by Mr. Sadler.

THE programme of summer rambles for the present season, published in connection with the biology section of the Essex County Education Committee, and prepared by Mr. E. C. Horrell with the assistance of Mr. F. J. Chittenden, should prove very useful to teachers of nature-study. It is noteworthy that two distinct rambles in different parts of the county are arranged for each Saturday afternoon during June and July, so that a large number of teachers is given the opportunity of attending. Each ramble is conducted by a member of the biological staff. The excursions are intended to afford opportunities to teachers to gain experience in the methods adopted in the study of nature in the field. Any teacher is eligible who takes an interest in general natural history, and is prepared to devote a little leisure to its study. There is no fee, but teachers bear their own expenses. The advice given to intending ramblers is sensible and practical, as the following quotations show:—"Students must not needlessly uproot plants, tread upon crops, break through fences, or leave gates open." "The teacher should always bear in mind that most biological and morphological facts can be illustrated quite as satisfactorily by a common plant as by a rare one, and a plant should never be collected simply because it is rare." It would be difficult to devise a better plan to secure rational nature-study work in our schools than this way of first educating the teachers to become intelligent observers.

IN a letter to the *Times* of June 8, Mr. Sidney Lee draws an interesting and instructive comparison between American and British methods of appointing university professors. Of the superiority of the American plan there can be no doubt. In America, as soon as a vacancy arises in the professorial staff, the president of the university consults members of the faculty concerned. He invites their opinion as to who is the fittest man to fill the vacant chair. But the president does not confine his inquiries to his immediate circle of colleagues. Knowledge of the reputations that men are acquiring in academic work is wonderfully well diffused. The president who is seeking to fill a vacant chair has at command ready means of communication with presidents and professors of other universities. After due and thorough investigation, he forms his decision as to how the vacant post may be filled with greatest advantage to the institution over which he presides. He then forwards an invitation to the chosen person to occupy the vacant office. The procedure in vogue in this country is too well known to require description, and the only argument Mr. Lee has found in its favour is that it enlarges the electors' field of choice. "But," he remarks, "this argument is open to most serious question. Men of ordinary sensitiveness often refuse to submit themselves to the humiliating ordeal of public or semi-public competition for a vacant professorship, which in many respects reduces them to the level of advertising vendors of quack medicines. In effect the prevailing system often narrows the field of choice open to the electors, who are not in the habit of looking outside the panel of self-appointed candidates; it is, indeed, doubtful if honourable regard for the terms of their public advertisements permit them such a course of action."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 30.—"Preliminary Note on the Use of Chloroform in the Preparation of Vaccine." By Alan B. **Green**, M.A., M.D. (Cantab). Communicated by W. H. Power, M.D., F.R.S.

Briefly stated, the method of preparing vaccine by the chloroform process is described as follows:—Vaccine emulsion is first prepared by triturating one part by weight of vaccine pulp with three parts by weight of water. Through this emulsion, air charged with chloroform vapour is passed, with the result that the water of the emulsion becomes saturated with chloroform (1 in 200). After such saturation all excess of chloroform immediately escapes automatically from the vaccine, and the lymph is not brought into contact with a stronger solution of chloroform than 1 in 200. The extraneous micro-organisms originally present in the lymph are by this means killed in from one to six hours, while the lymph remains fully potent for vaccination. Vaccinations have been performed with lymph prepared in this way with highly successful results.

By the chloroform process, lymph, free from extraneous micro-organisms, can be distributed for use twenty-four hours after collection from the calf, instead of after the lapse of a month or longer, which is the time generally necessary for the elimination of these organisms by the glycerine process. The rapid preparation of lymph by the chloroform process possesses many obvious advantages.

Zoological Society, May 12.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Mr. W. B. **Tegetmeier** exhibited a skin and some illustrations of a species of pheasant from Mongolia recently described under the name of *Phasianus hagenbecki*. He suggested that it would make a handsome addition to our coverts.—Mr. Frank **Finn** spoke on variation in wild mammals and birds, and exhibited illustrative living specimens and drawings. The specimens included a frontlet of the barking-deer (*Cervulus muntjac*), bearing supernumerary antlers springing from the bony pedicles below the ordinary antlers; two abnormally-coloured Sambhar deer (*Cervus unicolor*); a goldfinch (*Carduelis carduelis*), showing red patches at the back of the head; and an albinistic variety of the ruff (*Pavoncella pugnax*), with head and neck nearly white.—Mr. F. E. **Beddard**, F.R.S., exhibited preserved and injected brains of mammals prepared in the Society's prosectorium.—Dr. J. F. **Gemmill** read a contribution to the study of double monstrosities in fishes. It contained an account of the anatomy of double monster trout-embryos, reference being made to the fusion, disappearance, or modification of organs which occurred at the region of transition from the double to the normal condition.—Mr. Robert **Gurney** dealt with the metamorphoses of the decapod crustaceans *Ægeon fasciatus*, Risso, and *Æ. trispinosus*, Hailstone. The larvæ of the two species were described, and comparisons made with those of other Crangonidæ, from which it was shown

that the known larvæ of the British Crangonidæ fell naturally into three groups, representing the genera Ægeon (which would include Cheraphilus), Crangon, and Pontophilus.—Mr. C. Tate **Regan** read a paper on the fishes collected by Dr. Goeldi at Rio Janeiro. Four species were described as new.—Mr. Martin **Jacoby** described fifty-six new species of South American Coleoptera of the family Chrysomelidæ.

Geological Society, May 13.—Mr. E. T. Newton, F.R.S., vice-president, in the chair.—On some disturbances in the Chalk near Royston (Hertfordshire), by Mr. H. B. **Woodward**, F.R.S. The disturbed Chalk near Royston, with its fractured and displaced flints, occurs in conjunction with Boulder-clay, and the latter is found beneath a considerable thickness of disturbed Chalk. While Boulder-clay occurs along the high ground bounding the disturbed area to the south, the undulating downs to the north are devoid of this Glacial Drift. The facts were to be explained, on the land-ice theory, if the ice were at first welded to the rubbly surface-strata in regions north of the escarpment, and, when movement set in, there were overthrusts of débris-laden ice, and upper layers of ice were rent asunder from and moved over lower ones; while to the thrust or long-continued pressure of ice along shear-planes at the higher levels may be attributed the belt of disturbed strata.—On a section at Cowley, near Cheltenham, and its bearing upon the interpretation of the Bajocian denudation, by Mr. L. **Richardson**.—Description of a species of Heterastræa from the Lower Rhætic of Gloucestershire, by Mr. R. F. **Tomes**. The specimen was obtained from Lower Rhætic Beds at Deerhurst (Gloucester). It occurred a little above the bone-bed; it is specifically new and generically new to the Rhætic, and it displays Jurassic relationships. It differs from the several Liassic species in the small size of the corallum and of its calices.

Royal Meteorological Society, May 20.—Captain D Wilson-Barker, president, in the chair.—Mr. C. P. **Hooker** read a paper on the relation of the rainfall to the depth of water in a well. In this he gave the weekly measurements of the depth of water in a well (101 feet deep) and the amount of rainfall at Cirencester, extending over the sixteen years 1887–1902. The depth of water in the well depends on how much rain penetrates, and the penetration is determined by the amount of rain, the rapidity of its fall, and the existing condition of the soil. The winter rains penetrate easily, and the summer rains with difficulty. Mere absence of rain is not the only cause of scarcity, deficiency of spring rains, and subsequent heat and evaporation being far more important factors. After the early spring months but little rain penetrates to the well, so that a timely forewarning at that season might prove of great value by enabling the existing supplies to be husbanded at an early period. Considering how narrow is the boundary between sufficiency and want, and looking to the fact that every year sees further demands made on our water supplies, the author considers that it is of the utmost importance that more attention should be paid to the storage of our surplus winter rains. This might be done by the formation of large hill reservoirs, and doubtless such measures as the reafforesting of large tracts of land would be of use in checking the rapidity with which the rains reach the rivers and are so lost.—Mr. W. **Marriott** gave an account of the frost of April, which was so keenly felt coming after the long spell of very mild weather in February and March. The fortnight April 12–25 was marked by keen northerly winds, great dryness, and low temperatures. Frosts on the ground were of almost nightly occurrence, and as the result, the destruction of the fruit blossom has been very great and also very general. In many places a good deal of the apple and strawberry blossom, although only in bud at the time, was killed, while potatoes were cut to the ground, and the foliage of horse chestnuts and limes much injured, particularly on the windward side.

Royal Microscopical Society, May 20.—Dr. Hy. Woodward, F.R.S., in the chair.—Mr. C. L. **Curties** exhibited a new monochromatic light apparatus, which was a modification of that shown at the November meeting by Dr. Spitta. It consisted of an optical bench carrying a Nernst electric lamp, aplanatic bulls-eye condenser, adjustable slit, achromatic collimating lens, a prism upon which was mounted a Thorpe replica grating, and an achromatic projection lens, the whole being fitted upon a mahogany base capable of being tilted. The spectrum given was exceedingly brilliant, and any part could be brought into the field of the microscope.—Messrs. W. **Watson** and Sons exhibited a new form of museum microscope placed inside a locked glass case through which the eye-piece projected. There was a circular disc in place of the ordinary stage, upon which twelve slides could be fixed; it was rotated from the outside, so as to bring each object into the field. Messrs. Watson also exhibited a bulls-eye condenser of long focus for photomicrographic purposes, fitted with iris diaphragm and centring adjustments.—There was an exhibition of pond life by fellows of the Society and members of the Quekett Microscopical Club.—It was announced that at the next meeting on June 17 there would be a communication from Lord Rayleigh on Mr. Gordon's paper on the Helmholtz theory of the microscope, and that Dr. H. Siedentopf would give a demonstration of his method of making visible ultra-microscopic particles in glass, and the application of the method to bacteria.

CAMBRIDGE.

Philosophical Society, May 4.—Dr. Baker, president, in the chair.—On Mendelian heredity of three characters allelomorphic to each other, by Mr. W. **Bateson**, F.R.S. The object of this note was to direct attention to various possibilities attainable by a modification of the Mendelian method. In the ordinary method the constitution of the gametes in the first cross (F_1) is tested by breeding such individuals *inter se* or with a pure recessive. The ensuing generation (F_2) will consist of a mixture of dominant and recessive individuals; but if the proportions depart from the expected 3 : 1 or 1 : 1, it is not possible to tell whether such departure is due to change in relative numbers of dominant and recessive gametes, to imperfect segregation of characters, or to change in dominance. This question can in part be answered by a method which consists in crossing F_1 produced from a parent having one dominant character with another heterozygous individual having a different dominant character (the same recessive being used in both cases).—On the diathermancy of antimonite, by Mr. A. **Hutchinson**.—On the potential difference between the terminals of a vacuum tube, by Mr. W. A. D. **Rudge**. The experiments described in the paper were made in a tube which contained a perforated and movable metal disc. It was found that the presence of the disc caused the potential difference between the ends of the tube to rise considerably above that of a perfectly similar tube without a disc. The increase varied with the nature of the metal; using different metals as discs, the order of increase was Pb 1, Ag 1·25, (Cu Fe Zn) 1·35, Al 3·5, Mg 3·8.—The determination of curves satisfying given conditions, by Mr. H. **Bateman**.—On the existence of a radio-active gas in the Cambridge tap-water, by Prof. **Thomson**, F.R.S. (see p. 90).—On a continuous spectrum, by Mr. T. H. **Havelock**.—On the Thomson effect in alloys of bismuth and tin, by Mr. S. C. **Laws**. The quantity of heat evolved or absorbed in consequence of the temperature gradient when a current C passes between two sections of a homogeneous conductor the difference of temperature of which is δT may be represented by $C\sigma\delta T$. These experiments comprise some measurements of the quantity σ—the specific heat of electricity—in bismuth and alloys of bismuth and tin. Some values for σ obtained in this way are:—bismuth 860 ergs per absolute unit current per 1° C.; alloy containing 1·3 per cent. tin 10,700 ergs per absolute unit current per 1° C.; alloy containing 6 per cent. tin 11,200 ergs per absolute unit current per 1° C.—A preliminary account of an investigation of the effect of temperature on the ionisation of gases acted on by Röntgen rays, by Mr. R. K. **McClung**. This paper gives some of the results obtained in a series of experiments made to ascertain what effect the heating of a gas has on the amount of ionisation produced in it by the action of Röntgen rays. The results obtained show conclusively that the amount of ionisation is independent of the temperature of the gas when the density of the gas is kept constant. Observations were made on air for a range of temperatures of nearly two hundred degrees from about 9° C. to a little more than 200° C. Carbon dioxide was also examined for a slightly wider range of temperatures, and precisely the same result was obtained as for air.

EDINBURGH.

Royal Society, May 5.—Prof. Geikie in the chair.—Mr. J. G. **Goodchild** read a paper dealing with (1) Scottish cairngorms, amethysts, and quartz, (2) chalcedony, opal and jasper, in which many interesting details were given of the valuable collection in the Museum of Science and Art. Important questions as to the genesis of these minerals and the influence of environment were indicated as calling for careful investigation.—Mr. J. G. **Goodchild** also read a paper on the phonetics of Gaelic, a subject to which he had devoted attention for many years. A specimen of Gaelic, which Prof. Mackinnon had put together as containing all the different sounds used in Gaelic, was transliterated in the phonetic alphabet known as palæotype, and each sound was then discussed, especially in relation to its mode of production. The author argued that many of the peculiarities of Gaelic sounds were due to the resonance in the vestibule or chamber immediately above the glottis.—Dr. A. T. **Masterman** gave a brief note on the heart and pericardium in Enteropneusta, Echinodermata and their allies, sketching what he believed to be the process of embryological development. One stage he had not, however, been able as yet to observe.—Prof. C. G. **Knott** communicated a further instalment of his investigations into the interrelations of the resistance and magnetisation of nickel at high temperatures. In the later experiments the temperature was pushed up to about 400° C. The increase of resistance of a particular wire when magnetised was found to increase as the temperature was raised, but afterwards greatly to decrease. This was to be expected if we suppose that the greatness of this effect in the magnetic metals is due to their magnetisation. At the highest temperature reached the percentage change of resistance in a moderate field was about one-sixtieth of the value at ordinary temperatures.

May 18.—The Hon. Lord M'Laren in the chair.—Dr. Alex. M. **M'Aldowie** read a paper on the human plantar reflexes. The lower limb in infants was a prehensile limb, and the reflex movement when the sole was tickled was similar to that in monkeys. As the child began to try to walk, the character of the reflex changed, and became ultimately plantigrade in type. The prehensile reflex, however, remained in abeyance, and manifested itself in disease. Under these conditions it appeared as soon as the cerebral control was withdrawn or overcome, and thus permitted the spinal control to reassert itself. It was a remarkable fact that such a reflex, which disappeared so early in the individual life, should reappear under pathological conditions. The author considered that this permanence of the prehensile reflex indicated that the period in the development of the ancestors of the human race when the lower limb was an organ of prehension was one of immense duration.—Sir William **Turner**, K.C.B., in a paper on the occurrence of the sperm whale or cachalot in the Shetland seas, described in detail the lower jaw, the teeth, and the tympano-petrous bones of a large specimen which had been found dead near Hillswick, Shetland, in August, 1901. The animal was a male, and was 61 feet long. The point of a massive explosive harpoon was found imbedded in the head, and had penetrated the great chamber for the lodgment of the spermaceti, most of which had consequently drained away. Of the sixty-four teeth obtained, forty-two were mandibular, seven were doubtful, probably mandibular, but had never cut the gum, and the remaining fifteen belonged to the upper jaw. They were of various shapes, straight and curved, and were obviously rudimentary and functionless. The paper contained a history of other occurrences of sperm whales in the Shetland seas, and closed with a comparative study of the tympano-petrous bones of Physeter, Kogia, and other Odontoceti.—In a preliminary note on the shedding of scales in gadoid fishes, Mr. Alex. Wallace **Brown** brought evidence in favour of the view that these fish shed their scales before spawning, and that this shedding ceases when the fish cease spawning. Should this fact be established by future investigation, the ordinary view that the rings on the scales indicate years of growth will have to be abandoned.

PARIS.

Academy of Sciences, June 2.—M. Albert Gaudry in the chair.—On certain singularities of partial differential equations of the elliptic type, by M. Émile **Picard**.—On some new fossils from the Soudan, by M. A. **de Lapparent**. Further fossils found by Captain Gaden in the Soudan are undoubtedly Cretaceous in type. One of them, an ammonite, is related to the genus Mammites and also to Vascoceras. The sea must thus have extended as far as Tchad, and covered the Damerghou. It is nearly certain that during the Cretacean epoch it joined the Atlantic, and that the whole of Africa north of 13°–14° N. latitude was occupied by a vast sea, from which the high lands of Abyssinia and an island including Aïr, Tassali, Ahaggar and Tademaït emerged.—Astronomical and magnetic work at Madagascar, by M. P. **Colin**. A series of measurements of the magnetic elements showed a diminution in the declination at Tamarive of 11′ between May, 1902, and April, 1903, with a slight maximum in September; the inclination diminished 1′ 45″, and the horizontal component diminished by 0·00033.—On the infinitesimal properties of linear systems of circles, by M. **Mesuret**.—On the anisotropy of silk, and on the value of Poisson's ratio for this substance, by M. F. **Beaulard**. The results of the measurements given show clearly that silk is not isotropic.—On the magnetism of liquids and crystals, by M. Georges **Meslin**. No solid belonging to the cubical system exhibits the phenomenon of magnetic dichroism.—On the heat conductivity of iron in the magnetic field, by M. A. **Lafay**. The experiment of Maggi, which would appear to show that the heat conductivity of iron is affected in a magnetic field, is a convection phenomenon due to the air, and is not observed in a vacuum. There is some experimental ground for supposing that in a very intense magnetic field the conductivity of iron for heat is appreciably diminished, but the effects do not vary with variations in the direction of the magnetic and heat flux.—On the utilisation of energy for transmission in wireless telegraphy, by M. G. **Ferrié**.—On the radiations emitted by radio-active lead, by MM. **Korn** and **Strauss**. On comparing the photographic effect of equal quantities of radio-active lead, in the form of sulphate, one of which had been exposed to the influence of the kathode rays for ten minutes, it was found that the action on the photographic plate was much more intense in the case of the exposed sample. This effect could not be due to phosphorescence, since the photographic action was unaffected by interposing a thin plate of aluminium or black paper. No other radio-active material appears to show this effect, which is remarkable in that there is no corresponding increase in the electro-active power, the rate at which an electrified body is discharged remaining the same.—On the emanation of radium and its coefficient of diffusion in air, by MM. P. **Curie** and J. **Daune**. The view of Rutherford that the emanation of radium behaves as a gas is confirmed by a fresh experimental method. The fact that the emanation of radiation is condensed at the temperature of liquid air, first announced by Rutherford, is also confirmed.—On the purification of hydrogen on the industrial scale by cold, by M. Ch. **Renard**. Crude hydrogen passed at the rate of one to two litres per minute through a vessel containing liquid air is completely freed from hydrogen arsenide. The method may be practically useful in the purification of hydrogen for balloons.—On the cementation of steel, by M. Léon **Guillet**. The velocity of penetration of the steel by the carbon depends upon the temperature, the time, and the nature of the substance supplying the carbon. By simple cementation certain nickel steels acquire the same hardness as carbon steels, when the cementation of the latter has been followed by tempering.—The decarburation of steels and thin metallic plates by evaporation in a vacuum, by M. G. **Belloc**.—On the form assumed by mercuric iodide on separating from solution, by M. D. **Gernez**. When mercuric iodide is formed either by volatilisation or evaporation from solution at low temperatures, the unstable yellow form is produced.—Observations on the precipitation of manganese by persulphuric acid in acid solution, by M. H. **Baubigny**. A study of the effect of varying the volume of the solution in which the precipitation is carried out.—The alloys of copper and magnesium, by M. O. **Boudouard**. In a preceding paper the study of the fusibility curve indicated the existence of three definite combinations: Cu_2Mg, $CuMg$, and $CuMg_2$. In the present paper these results are confirmed by a metallographic study of the alloys.—On the silicides of chromium, by MM. P.

Lebeau and J. **Figueras.** Four silicides have been isolated, corresponding to the compositions $SiCr_3$, $SiCr_2$, Si_2Cr_3 and Si_2Cr. Details of the preparation and properties of Si_2Cr_3 are given.—The electrolytic reduction of unsaturated acids, by M. C. **Marie.** By the use of mercury as a kathode, the unsaturated acids may be reduced to the corresponding saturated acids.—On dibromo-acetylene, CBr CBr, by M. P. **Lemoult.**—On *Pyronema confluens*, by M. P. H. **Dangeard.**—On the botanical characters of the mycelium of the truffle, by M. Louis **Matruchot.**—The morphological characters of Pleurocecidia, by M. C. **Houard.**—On some fossil algæ in ancient strata, by M. B. **Renault.** As the result of a microscopical examination of boghead cannels the conclusion is drawn that these were formed by the accumulation of gelatinous algæ at the bottoms of lakes, each layer of coal being recognisable by the genus of algæ producing it.—On the present state of the volcano of Mont Pelée, by M. **Giraud.**—On the geology of the neighbourhood of Cinglais (Calvados), by M. A. **Bigot.**—On the graphical characters of fatigue in voluntary movements in man, by MM. A. **Imbert** and J. **Gagnière.**—The degradation of carbohydrates in the animal organism, by MM. A. **Bach** and F. **Battelli.** The theory is put forward that two alternating actions are at work, both produced by enzymes. The carbohydrates are first hydrolysed, with production of carbon dioxide, and then acted upon by an oxidising enzyme, with evolution of water. According to this view the carbon dioxide is never formed by direct oxidation, but by hydrolysis.

DIARY OF SOCIETIES.

THURSDAY, JUNE 11.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—The Bending of Eletric Waves round a Conducting Obstacle; Amended Result: H. M. Macdonald, F.R S.—On the Propagation of Tremors over the Surface of an Elastic Solid: Prof. H. Lamb, F.R.S.—The Diffusion of Salts in Aqueous Solutions: J. C. Graham.—On the Structure of Gold Leaf, and the Absorption Spectrum of Gold: Prof. J. W. Mallet, F.R.S.—On Reptilian Remains from the Trias of Elgin: G. A. Boulenger, F.R.S.—A Method for the Investigation of Fossils by Serial Sections: Prof. W. J. Sollas, F.R.S.—An Account of the Devonian Fish, *Palaeospondylus Gunni*, Traquair: Prof. W. J. Sollas, F.R.S., and Miss I. B. J. Sollas.—The Measurements of Tissue Fluid in Man; Preliminary Note: Dr. G. Oliver.—Observations on the Physiology of the Cerebral Cortex of the Anthropoid Apes: Dr. A. S. F. Grunbaum and Prof. C. S. Sherrington, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—Quaternions: Major P. A. MacMahon.—Automorphic Functions and the General Theory of Algebraic Curves: Mr. H. W. Richmond.—Jacobi's Construction for Quadric Surfaces: Prof. G. B. Mathews.—Addition to the Papers on Four Known Simple Groups of Order 25920: Prof. L. E. Dickson.

FRIDAY, JUNE 12

PHYSICAL SOCIETY, at 5.—Some Experiments on Shadows in an Astigmatic Beam of Light: Prof. S. P. Thompson.—The Positive Ionisation produced by Hot Platinum in Air at Low Pressures: O. W. Richardson.—On a Method of Determining the Viscosity of Pitch-like Solids: Prof. F. T. Trouton and E. S Andrews.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Eclipse of the Moon, 1903 April 11: F. W. Henkel.—Note on the Use of Peirce's Criterion for the Rejection of Doubtful Observations: S. A. Saunder.—On a Probable Relationship between the Solar Prominences and Corona: W. J. S. Lockyer.—Note on the Present Condition of the Lunar Theory: E. Nevill.—On the Relation between the Light Changes and Orbital Elements of a Close Binary System; with Special Reference to RR Centauri: A. W. Roberts.—Recent Observations of Mars and Jupiter: W. F. Denning.—The Spectra of Sun-spots in the Region B-D: Rev. A. L. Cortie.—Experiments as to the Actuality of the "Canals" observed on Mars: J. E. Evans and E. W. Maunder.—*Promised Papers*: Positions of 170 Stars around Nova Geminorum, and a Discussion concerning the Difference between two Exposures on the same Plate: F. A. Bellamy.—Examination of Mr. Whittaker's "Undulatory Explanation of Gravity" from the Physical Standpoint: G. Johnstone Stoney.—Observations of the Satellite of Neptune from Photographs taken with the 28-inch Refractor: Royal Observatory, Greenwich.—Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1902, deduced from Photographs taken at the Royal Observatory, at Dehra Dun (India), and in Mauritius: Royal Observatory, Greenwich.

MALACOLOGICAL SOCIETY, at 8.—A List of Species of Mollusca from South Africa, forming an Appendix to G. B. Sowerby's "Marine Shells of South Africa": E. A. Smith.—On a New Genus, Planorbia, Moore, from the Albert Edward and Albert Nyanzas: J. E. S. Moore.—Notes on Some Jurassic Shells from Borneo, including a New Species of Trigonia: R. Bullen Newton.—Description of *Marginella lateritia*, n.sp., from the Andaman Islands: J. C. Melvill and E. R. Sykes.—New Mollusca from New Zealand: Rev. W. H. Webster.

MONDAY, JUNE 15.

VICTORIA INSTITUTE, at 4.30.—Annual Meeting.—Address by Prof. W. M. Flinders Petrie.

TUESDAY, JUNE 16.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.—On an Extinct Species of Genet (*Genetta plesictoides*) from the Pleistocene of Cyprus: Miss Dorothy M. A. Bate.—Description of a New Fish of the Gobiid Genus Rhiacichthys from British New Guinea: G. A. Boulenger, F.R.S.—Descriptions of New Reptiles from British New Guinea: G. A. Boulenger, F.R.S.—The Marine Fauna of Zanzibar and British East Africa, from Collections made by Mr. Cyril Crossland in the Years 1901 and 1902—Polychæta, Part II.: Cyril Crossland.

INSTITUTION OF CIVIL ENGINEERS, at 9.—"James Forrest" Lecture, Some Unsolved Problems in Engineering: W. H. Maw.

WEDNESDAY, JUNE 17.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Theory of Optical Images, with Special Reference to the Microscope: Lord Rayleigh, F.R.S.—On a Method of making Visible Ultra-microscopic Particles in Glass, and the Application of the Method to Bacteria: Dr. H. Siedentopf.—On the Lag in Microscopic Vision: E. M. Nelson.

CHEMICAL SOCIETY, at 5.—(1) The Estimation of Arsenic in Fuel; (2) The Electrolytic Estimation of Minute Quantities of Arsenic, more Especially in Brewing Materials: T. E. Thorpe.—Crystallised Ammonium Sulphate and the Position of Ammonium in the Alkali Series: A. E. H. Tutton.—Action of Hydrogen on Sodium: A. Holt, jun.—(1) The Action of Halogens on Compounds containing the Carbonyl Group; (2) Reactions involving the Addition of Hydrogen Cyanide to Carbon Compounds: A. Lapworth.—The Acetoacetic Ester Synthesis: A. C. O. Hann and A. Lapworth.—Rimu Resin: T. H. Easterfield and B. C. Aston.—Note on the Karaka Fruit: T. H. Easterfield and B. C. Aston.

INSTITUTION OF CIVIL ENGINEERS, at 10 a.m.—Inaugural Address of the Engineering Conference: John Clarke Hawkshaw.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Meteorological Aspects of the Storm of February 26–27, 1903: Dr. W. N. Shaw, F.R.S.—The Dines-Baxendell Anemograph and the Dial-pattern Non-oscillating Pressure-plate Anemometer: Joseph Baxendell.

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—*Probable papers*: (1) Surface Flow in Crystalline Solids under Mechanical Disturbance: (2) The Effects of Heat and of Solvents on Thin Films of Metal: G. Beilby.—The Magnetic Expansion of some of the Less Magnetic Metals (with an Appendix by G. A. Schott): Dr. P. E. Shaw.—On the Discharge of Electricity from Hot Platinum: Dr. H. A. Wilson.—The Bionomics of *Convoluta Roscoffensis*, with Special Reference to its Green Cells: Dr. F. W. Gamble and F. Keeble.—New Investigations into the Reduction Phenomena of Animals and Plants: Preliminary Communication: Prof. J. B. Farmer, F.R.S., and J. E. S. Moore.—The Action of Choline, Neurine, Muscarine and Betaine upon Isolated Nerve (and upon the Excised Heart): Dr. A. D. Waller, F.R.S., and S. C. M. Sowton.—The Physiological Action of Betain Extracted from Raw Beet Sugar: Dr. A. D. Waller, F.R.S., and Dr. R. H. Aders Plimmer.—On the Physiological Action of the Poison of the Hydrophidæ; Part II. Action on the Circulatory, Respiratory and Nervous Systems: Dr. L. Rogers.—A Paper on the Spectra of Neon, Krypton and Xenon: E. C. C. Baly.—A Study of the Interaction of Mercury and Nitric Acid: Prof. P. Chandra Rây.—And other Papers.

LINNEAN SOCIETY, at 8.—Descriptions of New Chinese Plants: S. T. Dunn.—On the Life-history of a New Indian Species of Monophlebus: E. P. Stebbing.—On the Anatomy of Leaves of British Grasses: L. Lewton-Brain.—Scottish Freshwater Plankton.

FRIDAY, JUNE 19.

ROYAL INSTITUTION, at 9.—Radium: Prof. Pierre Curie (in French).

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