THURSDAY, NOVEMBER 12, 1896.

GALOISIAN ALGEBRA.

Lehrbuch der Algebra. Von Heinrich Weber. Erster Band. Pp. xvi + 654. (Braunschweig: Vieweg und Sohn, 1895.)

A "Treatise on Algebra" is rarely found to fulfil the promise of its title. It is too often a mere collection of problems and examples, thrown together without much regard to order or method; such theory as the book contains is often imperfect, and occasionally even incorrect; and no attempt is made to suggest the idea of an ordered system of algebra, which proceeds along natural lines of development.

Prof. Weber's treatise is a work of an entirely different stamp. It is designed upon a perfectly definite, well-considered plan; its foundations are laid with the utmost care and precision; and the reader is carried on from stage to stage until he is abreast of some of the most interesting, as well as the most recent, of mathematical discoveries. The work may be described, in general terms, as a treatise on ordinary algebra, with special reference to its arithmetical applications; with the addition, subsidiary to the main subject, but very important in itself, of the theory of groups. But in order to give anything like an adequate idea of the author's scope and method, it will be necessary to analyse the different parts of his book in some detail.

The introduction is entirely arithmetical; at the same time it is an indispensable prelude to all that is to follow. It contains the elements of the theory of multiplicities, a rigorous theory of rational and irrational numbers, and a proof of the continuity of real numerical magnitude. The demonstrations are mostly inspired by Dedekind; but it is shown that Cantor's procedure leads to equivalent results. It is to be specially observed that the definitions of rational fractions, ratios, irrational, negative, and complex numbers are entirely independent of any hypothesis about the existence of divisible concrete quantities; and similarly with regard to the statements and proofs of the various propositions. Perhaps in the whole range of mathematics no more abstract reasoning can be found than that by which the continuity of numerical magnitude has been established; and it is very instructive to compare the vague, illusive glimmering of the truth afforded by "intuition" with the precise and logical *Begriff* which has been developed by the persevering effort of mathematical speculation. This is one of the cases where

> "obstinate questionings
> Of sense and outward things"

have justified their stubbornness by leading to discoveries of the highest importance. Arithmetic, and consequently he whole of analysis, has now been absolutely and finally freed from all necessity of appealing to theories or assumptions foreign to its own nature; and the effect of this liberation is already showing itself in many different ways. Thus, for example, in the first book of Prof. Weber's work will be found (pp. 101–126) a strictly arithmetical proof of the fundamental proposition that every algebraical equation in one variable with numerical coefficients has at least one real or complex numerical root. It is true that the proof is accompanied by a geometrical figure, but this is merely for the sake of convenience, and does not affect the real nature of the demonstration. The same thing applies to the proof (pp. 132-6) that the roots of an equation are continuous functions of its coefficients.

The first Book is to a great extent preparatory. It treats, in order, of rational functions of one or more variables, determinants, the existence of roots of algebraic equations, symmetric functions, invariants and covariants, and Tschirnhausen's transformation. The portions most worthy of remark are the proof of the existence of roots as numerical quantities, already alluded to, and the chapter on the Tschirnhausen transformation, which gives a very clear account of Hermite's modified form of the process, by means of which the coefficients of the transformed equation are expressible as simultaneous invariants of the original quantic $f(z)$ and a certain auxiliary quantic $T(z)$. The method is applied to the reduction of the general quintic to the normal forms which are associated with the names of Bring (or Jerrard) and Brioschi.

Book II. deals with the roots of algebraical equations, and comprises six chapters. Of these the first discusses the reality of the roots. The solution of quadratic, cubic, and biquadratic equations is followed by the proof of an important property of the Bezoutiant, namely, that if, by a real linear transformation, the Bezoutiant of $f(z)$ is expressed as a sum of π positive and ν negative squares which cannot be reduced to a smaller number, then $\pi + \nu + 1$ is the number of distinct roots of $f(z)=0$, and of these $\pi - \nu + 1$ are real, and the rest imaginary. (It is understood, of course, that all the coefficients of $f(z)$ are real.) This leads to a digression on Sylvester's Law of Inertia of quadratic forms; after which an application of the theorem about the Bezoutiant is made to the general cubic and biquadratic, and to two special quintic equations.

The Law of Inertia itself is proved in Book I. (p. 183–4): it may perhaps be remarked that on p. 184, line 17, the phrase, "aus diesen μ Gleichungen" is not very clear. What is really meant is the system of μ linear equations, by means of which (*ex hypothesi*) $Z_1, Z_2 \ldots Z_\mu$ are expressible in terms of $Y_1, Y_2 \ldots Y_\nu, Z^1{}_1, Z^1{}_2 \ldots Z^1{}_{\mu 1}$. The supplementary articles on the law of inertia (pp. 255–265) explain how the characteristic numbers π, ν for a given quadratic form may be deduced from the coefficients of the form.

Chapter viii., which next follows, contains an account of Sturm's Theorem which is very fresh and interesting, and includes Hermite's determinants, which may be used instead of the Sturmian functions proper. After this comes a sketch of Kronecker's remarkable theory of characteristics, and an application of it to Gauss's first proof of the existence of roots of equations.

Chapters ix. and x. treat of the separation and approximate calculation of roots. On the whole they follow the traditional lines; and we confess that we did not find them so interesting as the rest of the work. From the author's own point of view, they are, in a sense, superfluous; and, in fact, no use is made of them subsequently. Then from the practical point of view it is hardly satisfactory to fill up three pages with an account of Daniel Bernoulli's method of approximation, and omit all mention of Horner's algorithm. Still these chapters are redeemed from commonplace by a very elementary proof of Newton's Rule (first demonstrated by Sylvester), a geometrical excursus, after Klein, and some very curious theorems of Laguerre's relating to equations with no imaginary roots.

Chapter xi. discusses continued fractions, arithmetical equivalence, and the theory of the reduction of quadratic irrational numbers. A quadratic irrational $\{a, b, c\}$ is defined to mean

$$\{a, b, c\} = \omega = \frac{\sqrt{D} + b}{2c} = \frac{2a}{\sqrt{D} - b}$$

where

$$D = b^2 + 4ac,$$

and a, b, c are ordinary integers. Thus ω is a definite root of the equation

$$c\omega^2 = a + b\omega ;$$

so that the author makes two alterations in the traditional notation of Gauss and Dirichlet. One of these, the substitution of b for $2b$, needs no justification, and has, indeed, become almost inevitable; the reason for the change of sign in c is less obvious, especially as on p. 390 the typical quadratic equation is written

$$A + B\Omega + C\Omega^2 = 0$$

with

$$B^2 - 4AC = D.$$

It is true that, in consequence of this additional modification, there is a trifling gain of typographical elegance; but this seems to be outweighed by other disadvantages.

This chapter concludes with the approximate calculation of roots by means of continued fractions, a brief discussion of rational roots, and a very meagre treatment of what is really a fundamental problem, namely the resolution of a polynomial with integral coefficients into its irreducible factors. It is true that a method is given which is theoretically sufficient, but this is quite useless in practice; while, on the other hand, the purely tentative method illustrated by an example can only be made conclusive by special artifices. Some account ought, we think, to have been given of Kronecker's algorithm (Crelle, vol. 92), which, although tedious, is really practicable, and has the advantage of giving a definite answer after a finite number of trials which may be estimated beforehand.

Chapter xii. contains the elementary theory of the roots of unity, primitive roots to a modulus, indices, quadratic residues, and the law of quadratic reciprocity: the proof of this last is the trigonometrical one of Eisenstein.

We now come to Book III., on "Algebraical Quantities," and here the essential and characteristic part of the work may be said to begin. The key-note is struck at the commencement of chapter xiii. by the definition of a numerical corpus (*Zahlkörper*). The notion of a corpus, which is of the most fundamental character, is due to Dedekind, and is as follows. Let us take a finite or infinite system of elements α, β, γ, &c., concerning which nothing is assumed except that they can enter into rational combination according to the rules of ordinary algebra; then the totality of all rational functions of α, β, γ, &c., except those which involve division by zero, constitutes a corpus, denoted by

$$\Omega(\alpha, \beta, \gamma \ldots).$$

The simplest corpus is that of all rational numbers. This is contained in every other corpus; for if ω be any element of the corpus, then by definition the corpus contains ω/ω, that is, unity; and from this all other rational numbers may be derived by rational operations only.

If the elements of a corpus are all numbers, it is called a numerical corpus; but the elements may be independent variables, or even variables subject to algebraical conditions.

If $\Omega(\alpha, \beta, \gamma \ldots)$ is any corpus, and x any quantity not contained in it, the corpus $\Omega(x, \alpha, \beta, \gamma \ldots)$ is said to be derived from $\Omega(\alpha, \beta, \gamma \ldots)$ by the adjunction of x.

If z is an undetermined variable, the polynomial

$$f(z) = a_0 z^m + a_1 z^{m-1} + \ldots + a_m$$

is said to be a function in Ω when all the coefficients a_0, $a_1, \ldots a_m$ belong to Ω.

When Ω is given, we may, if we like, regard all the quantities belonging to it as rational: for this reason Kronecker calls a corpus a domain of rationality.

A function in Ω is reducible (in Ω) if it can be resolved into the product of two functions in Ω. A function which is irreducible in Ω may be reducible in a corpus derived from Ω by adjunction.

Let $f(z)$ be an irreducible function in Ω, of the nth degree in z; then the equation

$$f(z) = 0$$

is assumed to have n conjugate roots $z_1, z_2 \ldots z_n$. If Ω is a numerical corpus, the roots have actual numerical values; but this is really immaterial so far as the general algebraic theory of the corpus is concerned.

By the separate adjunction of the roots, we obtain the conjugate corpora $\Omega(z_1), \Omega(z_2) \ldots \Omega(z_n)$, each of which is called an algebraical corpus of the nth degree. These conjugate corpora are not necessarily all different; they may, in fact, be all identical, and the corpus is then called a Galoisian or normal corpus. In this case all the roots z_i are expressible as rational functions of any one of them, and this leads to the definition of a normal (or Galoisian) equation.

In the chapter we are now considering, the author proves the important theorem that the simultaneous adjunction of several algebraic quantities is equivalent to the adjunction of one only, provided that it be appropriately chosen; develops the distinction between primitive and imprimitive corpora; defines the Galoisian resolvent of an equation; and shows that the corpus $\Omega(z_1, z_2, \ldots z_n)$, derived from n conjugate corpora, is normal. This last proposition is the master-key to the whole Galoisian theory. After this we have a discussion of the substitutions of a normal corpus; it is important to observe that their number is equal to its degree. Then comes a brief digression on the elements of the theory of permutation-groups; and this leads to the very important conclusion that the group of μ substitutions of a normal corpus which contains n conjugate algebraical corpora is isomorphic with a certain group of permutations of n things. This may be regarded as a group of permutations of the n conjugate roots, and is then called the Galoisian group of the corresponding equation.

The problem of the algebraical solution of an equation ultimately depends upon the nature of its Galoisian group, or, which comes to the same thing, of its Galoisian resolvent. The degree of this resolvent is equal to μ, the degree of the Galoisian group; if this is equal to n! (n being the degree of the proposed equation), the equation is said to have no *Affect*. So long as we confine ourselves to the corpus $\Omega(a_0, a_1, \ldots a_{n-1})$, the general equation

$$a_0 z^n + a_1 z^{n-1} + \ldots + a_{n-1} = 0$$

has no *Affect*. But, by the adjunction of an appropriate algebraical quantity, the Galoisian resolvent may become reducible, and then any one of its irreducible factors is a Galoisian resolvent in the new domain of rationality. The process may admit of repetition, and we may say that the problem ultimately consists in finding algebraical quantities of the simplest possible kind, so that by their successive adjunction we may obtain a series of resolvents of lower and lower degree. No such reduction can be effected by the adjunction of irrationalities which are not contained in the normal corpus $\Omega(z_1, z_2, \ldots z_n)$ which is derived from the original equation. After the proof of this very important result (p. 516), the chapter concludes with a further discussion of imprimitive groups, with special reference to the Galoisian resolvent.

Chapter xv., on cyclical equations, contains applications of the foregoing theory, and should be read concurrently with chapter xiv. by those to whom Galois's theory is new. First of all, the general cubic and biquadratic are solved by a direct application of group-theory; and we are then introduced to the theory of Abelian and cyclic equations. An Abelian equation is a normal equation whose Galoisian group is commutative. It is not necessarily irreducible; on the other hand, an irreducible equation with a commutative group is necessarily Abelian (p. 535).

A cyclical equation is one whose group consists of a single cyclical substitution and its powers; in other words, when its roots may be arranged in such an order that all cyclical functions of them are rational. The solution of any Abelian equation may always be reduced to that of a system of cyclic equations (§ 163). The chapter concludes with the solution of cyclic equations by means of Lagrange's resolvent.

Chapter xvi., on cyclotomy, gives the theory of Gauss's periods, of the auxiliary functions which Jacobi denotes by $\psi_\lambda(a)$, of the solution of cyclotomic equations by their means, and of Gauss's sums. It concludes with applications to complex numbers of the forms $x + yi$, $x + y\rho$, ρ being a cube root of unity. It may be observed that the properties of the numbers $\psi_\lambda(a)$ are very fully treated in Jacobi's lectures on the theory of numbers. These are not included in his collected works; but MS. copies of Rosenhain's redaction of them may be picked up occasionally.

Chapter xvii. contains a series of remarkable propositions, which are proved with comparative ease by means of the foregoing theory. First of all it is shown that if P, the group of an equation, is reduced by the adjunction of the roots of an Abelian equation, P has a normal divisor Q, the index of which is a prime; and, conversely, if P has a normal divisor of this kind, P may be reduced in the manner stated. (By a normal divisor of P is meant a self-conjugate sub-group, or, as Klein calls it, an "ausgezeichnete Untergruppe.")

We then pass on to the theory of metacyclic equations. A metacyclic equation is defined as one whose complete solution may be made to depend on that of a series of cyclic equations. It is shown (p. 598) that the necessary and sufficient condition to be satisfied by a metacyclic equation is that there should exist a series of groups

$$P, P_1, P_2, \ldots 1$$

(of which the first is the Galoisian group of the equation) such that each group is a normal divisor, with prime index, of the group immediately before it in the series.

It is subsequently proved (§ 180) that the group of a metacyclic equation of prime degree is linear; that is to say, if its roots are

$$x_1 x_2 \ldots x_t \ldots x_p$$

the group consists of the $p(p-1)$ permutations of the suffixes defined by

$$t' \equiv at + b \pmod p$$

where a may have any of the values $1, 2, \ldots (p-1)$, and b any of the values $0, 1, 2 \ldots (p-1)$.

Conversely every irreducible equation of prime degree whose group is linear, is metacyclic (p. 615).

A function of the roots x_t which is unaltered by the permutations of the linear group, and by these only, is called a metacyclic function. Every metacylic function is a root of a rational equation $F(y)=0$ of degree $(n-2)$! and the function y may be so chosen that this equation has no multiple roots. Assuming that y has been so chosen, the necessary and sufficient condition that a given equation $f(x)=0$ may be soluble by radicals is that the resolvent $F(y)=0$ has a rational root (p. 620). This very beautiful proposition is the complete answer to the question first definitely put by Abel, namely: What algebraical equations are soluble by radicals?

At the end of this chapter will be found a very interesting application to metacyclic quintics. Among other things it is shown that if λ and μ are any two rational quantities, and

$$\alpha = \frac{5^5\mu^4\lambda}{(\lambda-1)^4(\lambda^2+6\lambda+25)}, \quad \beta = \frac{5^5\mu^5\lambda}{(\lambda-1)^4(\lambda^2+6\lambda+25)}$$

the quintic

$$x^5 + \alpha x + \beta = 0$$

may be solved by radicals.

One problem still remains: the actual construction of all possible metacyclic equations. This is considered in chapter xviii., the last in vol. I. The complete solution was announced by Kronecker, in his usual oracular way, in the Berlin *Monatsberichte* for 1853 and 1856. Prof. Weber here supplies us with a demonstration, which reproduces in an improved and simplified form his own Marburg memoir of 1892. It is based upon the properties of Lagrange's resolvent; and although it is impossible to analyse it in detail, the final result may be stated.

"Every root ξ of a metacyclic equation of prime degree n may be expressed in the form

$$\xi = A + \sum_{s=1}^{s=n-2} K_s \tau_s^{r_{n-2}} \tau_{s+1}^{r_{n-3}} \ldots \tau_{s+n-2}^{r_1}$$

where A is a rational quantity, $\tau_s = \sqrt[n]{k_s}$, K a rational function of k_s the form of which is the same for all values of s. The quantities k_s are the roots, different from each other, and from zero, of a cyclical equation of degree $(n-1)$. The exponents $r_0, r_1, \ldots r_{n-2}$ are the least positive residues of $1, g, g^2, \ldots g^{n-2}$ to the modulus n; g being a primitive root of n. The n values of ξ, obtained from this formula by giving to the radicals r_s their different values, are the roots of one and the same rational equation.

"Moreover every quantity ξ of this form is the root of an equation of the nth degree rational in the corpus K, whose elements are the coefficients of the equation satisfied by $k_0, k_1 \ldots k_{n-2}$. This equation in ξ is irreducible, except in the special case when one of its roots is rational." (With regard to the last clause, see the Corrigenda at the end of vol. II.) If the corpus K is real, the quantities k are either all real or all imaginary (see p. 551); in the first case one root ξ is real and the rest imaginary, in the second case all the roots ξ are real.

The last five pages of this volume contain the explicit determination of all metacyclic quintic equations.

An account of vol. II., and a general review of the whole work, is reserved for another article.

G. B. M.

OUR BOOK SHELF.

Hours with Nature. By Rambramha Sanyal, C.M.Z.S. Pp. 168. (Calcutta: Lahiri, 1896.)

As a first attempt on the part of a native Indian naturalist to familiarise his countrymen with some of the leading facts in nature, and to cultivate in them the faculty of observation, this little volume is clearly entitled to a welcome at our hands. To criticise the English would obviously be unfair, seeing that the author is writing in a foreign tongue; and, indeed, if this be borne in mind, his work is worthy of all praise, so far as this point is concerned.

Babu Sanyal, as stated on the title-page, is Superintendent of the Calcutta Zoological Gardens, where he has many opportunities of observing the habits of animals but little known in Europe. One communication from his pen—on the habits of Bennett's Mungoose (*Cynogale bennetti*)—has already appeared in the London Zoological Society's *Proceedings*; and it is a matter for regret that other observations on the habits of animals under his charge have not found a place in this volume. As the book is essentially a medley, to give an account of its contents is somewhat difficult. It commences with the description of an excursion in Bengal, in the course of which we are introduced to the Gangetic dolphin, kingfisher, and various other birds, squirrels, and the famous Botanical Garden at Calcutta. Chapter ii. gives us a history of the former superintendents of that institution, mainly compiled from the official handbook. In the third chapter the author takes the misapplication of the term "mole" to the Indian musk-shrew as the text for a sermon on moles and shrews; while in the next section we pass to such a widely different subject as an aquarium and its denizens. Of the other chapters, we can only mention that the sixth describes the tour of a party of Bengalis round the Indian Museum, Calcutta, while the ninth relates to Indian snakes; perhaps the best in the book, the author emphasising the "rib-walking" character of these animals. If the book reaches a second edition, we would, however, advise him to study Mr. Boulenger's works, when he would probably amend his classification of reptiles, and point out some means of distinguishing between snakes and limbless lizards.

It may be hoped that this little work may succeed in its object of awakening a love of nature, and exciting observation among our Bengali fellow-subjects.

R. L.

Elements of Astronomy. By Sir Robert Ball, LL.D., F.R.S. New edition, thoroughly revised. Pp. 469. (London: Longmans, Green, and Co., 1896.)

THIS edition has been subjected by the author to a thorough revision, special attention having been paid to the last chapter, which deals exclusively with astronomical constants. These latter will be found most interesting and valuable to all classes of astronomical students, for besides being presented with the facts in each case, references as to the source of information are always added. Little need be said about the other chapters, as the revision seems to have been very thorough, although occasional omissions have been found. We may, however, mention that the illustration on page 44 seems to be rather out of date, and might have been changed for one more modern. In paragraphs relating to stellar classification, perhaps it would have been better to refer to a more recent classification, in which we have every reason to believe that stars do not simply decrease in temperature, but both increase and decrease. Putting aside these two minor details, the book will prove an excellent text-book for those wishing to acquire a knowledge of the more important problems relating to astronomy. The admirable index attached will be found most complete.

Practical Work in Physics. By W. G. Woollcombe, M.A., B.Sc. Part iii. Light and Sound. Pp. x + 94. (Oxford: Clarendon Press, 1896.)

THIS is the third part of a course of practical physics, the two previous ones dealing with heat and general physics. A fourth part, on electricity and magnetism, will complete the work. The optical experiments in the present volume illustrate photometry, reflection at plane and at spherical surfaces, refraction at plane surfaces, and through lenses. The experiments in sound demonstrate the laws of transverse vibrations of wires, velocity of sound through gases and through solids, and interference of sound-waves. Only inexpensive apparatus is needed in order to carry out the experiments described, and the instructions, both as to construction of apparatus and performance with it, are clear and practicable. Experiments in sound depend upon the physiological perception of tone, and some students are unable to accurately perform them. The number of students with no "ear for music" (musicians will, perhaps, pardon the designation of the twanging of a monochord as music) is, however, very small. Mr. Woollcombe says that only five per cent. of his students have so little musical sense that the experiments in sound he describes cannot be satisfactorily carried out by them; and his experience is about the same as that of most teachers and demonstrators of physics.

Peasblossom. The Story of a Pet Plant. By Caroline Pridham. Pp. 180. (London: John Heywood.)

TAKEN altogether, this book is very attractively written. The descriptions are couched in the simplest words, and no botanical terms are used without full explanation. Observation is the basis of the text, and the development of a plant is traced from germination upwards, all the parts and all the stages being considered. The book will interest young readers, and will encourage them to study the life-history of common plants; the knowledge they will thus gain from text and nature will be worth having.

LETTERS TO THE EDITOR.

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

The Austro-Hungarian Map of Franz Josef Land.

IN common with all who take an interest in Arctic research, I was very much surprised to learn, on the return of the *Windward*, last year, that the Jackson-Harmsworth polar expedition had detected, what seemed to them, extraordinary inaccuracies in Payer's map of Franz Josef Land. Finding, however, that Mr. Jackson's sledge journeys had only been directed along the very outskirts of the region laid down by Lieut. Payer, I came to the conclusion that the discrepancies pointed out were no greater than might be expected in a part of the map, where the Austrian explorer had obviously meant rather to indicate the presence of some geographical feature, than to give its exact position. I also hoped that Mr. Jackson's persevering endeavours would eventually lead him to some point where he could effect a satisfactory juncture of his own survey with that of his predecessor.

When, however, on August 13 last, I had the great pleasure of meeting Dr. Nansen at Vardö, a few hours after he had landed from the *Windward*, I was absolutely astounded when he informed me, with evident distress, that the northern part of the well-known map of Austria Sound was utterly wrong. Indeed the circumstantial and graphic telegrams, which at that moment were being flashed round the whole globe, told how Dr. Nansen and Lieut. Johansen, on their unparalleled return journey, had failed to identify a single geographical feature discovered by the intrepid Austrian explorer; how, on the contrary, they had, on August 6, 1895, found three snow-covered islands in 81° 38′ N. lat. and about 63° E. long., and how they afterwards slowly worked their way to their winter quarters in 81° 12′ N. lat. and 56° E. long.; thus, to all appearance, actually crossing Payer's sledge tracks without finding any agreement with his map. The three islands just mentioned would, according to Dr. Nansen's determination, come in the very middle of Lieut. Payer's Dove Glacier. The publication of Dr. Nansen's book can alone enable geographers to decide as to the relative positions that Austria Sound and the three islands of the Norwegian explorers have to occupy on the map.

Respecting the accuracy of the southern part of Lieut. Payer's map, there can be no doubt whatever; for if we turn to the third section of the "Denkschriften der Kaiserlichen Akademie der Wissenschaften," Band xxxv., Vienna, 1878,[1] we shall find from Weyprecht's paper on the astronomical and geodetic results of the Austro-Hungarian Arctic expedition, that the latitudes and longitudes of the *Tegetthoff* in the land ice, and of certain points on the neighbouring coast, notably Cape Tegetthoff and the western extremity of Wilczek Island, have all the precision that could be obtained from a long series of meridian altitudes, and no less than 218 lunar distances,[2] combined with a systematic triangulation. This triangulation was connected with all the neighbouring islands within a distance of some 30 or 40 miles. The satisfactory character of this part of the map was proved by Mr. Leigh Smith, who, during his first voyage to Franz Josef Land, passed close under Cape Tegetthoff and the south-western shore of Wilczek Island, where he saw, but did not visit, the large cairn in which the Austrian explorers placed a number of documents and a minimum thermometer. (See "Denkschriften," *l.c.*, p. 67, where the late Lieut. Weyprecht placed on record directions for opening the cairn without moving the thermometer from its horizontal position, and thus sacrificing the valuable indication it may yet afford.)

Naturally the survey grew less accurate when it came to be extended up Austiia Sound; but even there the latitudes, at least, must be very near the truth, as they are founded on numerous meridian altitudes of the sun. Fortunately an observation was secured in 81° 57′ N. lat. within a few miles of the most northern point reached. Hence there is no reason whatever to doubt that Lieut. Payer and his two companions, Midshipman Orel and the seaman Zaninovich, attained the latitude of 82° 5′, as detailed in the document now lying in a bottle on the summit of Cape Fligely. Unfortunately there is not the same certainty with regard to the longitudes, at least in the northern part of the map, as they rest solely on compass azimuths or bearings taken with the theodolite, often observed under very unfavourable conditions. (See Payer's "New Lands within the Arctic Circle," vol. ii. p. 77.) Had circumstances permitted the astronomical determination of a single longitude near the northern limit of the survey, no uncertainty as to the position of even the remoter parts of Austria Sound could have arisen. In conclusion, it may be mentioned that Lieut. Payer has deposited with the Royal Geographical Society all the materials used in the construction of his map; it is quite possible that a careful revision of these papers may remove the remaining uncertainty which, at present, hangs over the position of the northern part of the land which my old comrade explored in the face of so many difficulties.

RALPH COPELAND.

Royal Observatory, Edinburgh, November 6.

[1] This volume is devoted exclusively to the scientific results of the expedition under Payer and Weyprecht.

[2] Near the poles lunar distances define the observer's position much more accurately than in lower latitudes, not only because the degrees of longitude are less, but also on account of the smaller parallax in right ascension. It is therefore earnestly to be desired that explorers on boat or sledge journeys should avail themselves of this invaluable method.

The Inheritance of Specific Characters.

PROF. MELDOLA (NATURE, October 22, p. 594), referring to the increasing breadth of carapace in growing crabs, suggests as an alternative to selection acting during the present life of the individuals, that "breadth of carapace . . . had a selection value in the phylogeny; now this character appears at a late stage in the ontogeny." Before accepting this interesting suggestion as plausible, one would like to hear, from Prof. Meldola or any one else, of other instances in which a character that has been of selection value "in the past history of the species" does not appear until a late stage in the present individual history. My own knowledge does not extend further than the fact that such characters tend to be inherited at an earlier stage; of their inheritance at a later stage, I know no instances. Were this a universal principle, the selection of broader carapaced individuals must have taken place not very long ago, the conditions can hardly have been very different to now, and, as now, the character must have appeared at a late state in the ontogeny; in short, Prof. Meldola's alternative would only shift the need for an explanation a little distance back. The principle, however, may not be so general in its application as many of us have been led to believe. But, since in zoological speculation an hypothesis should be proved consonant wlth some known fact, Prof Meldola may fairly be asked to adduce facts in harmony with the idea which he states he has always entertained.

Since your report of the discussion on Neo-Lamarckism in Section D at the British Association meeting will doubtless be regarded as authoritative, may I take this opportunity of correcting the sentence, "Mr. F. A. Bather thought the Ammonites afforded at least some proof of the Neo-Lamarckian doctrine." He may have "thought" so, though I greatly doubt it, but he certainly did not say so. He was using the Ammonites as an example, to ask Prof. Lloyd Morgan how a modification of the senile parent could affect the limits of variation in its offspring, most of which had already been produced; or how modification even of the adult could affect the limits of variation in its offspring, which do not present the character of the assumed modification until they themselves become adult. The point of these questions would be more obvious to your readers, had your report alluded to the thesis that I imagined to constitute Prof. Lloyd Morgan's main contribution to the discussion.

F. A. BATHER.

IN the first place, I will take the opportunity afforded me by Mr. Bather, of correcting a slip in my letter; it is narrowness of carapace that is being, or has been, selected, and not breadth, as I stated. This, however, in no way affects the suggestion. In the next place, I must part company from Mr. Bather on a point of fundamental principle. I decline to accept, as a canon of scientific method, that a zoological (why particularly "zoological"?) hypothesis put forward in explanation of a body of facts still under investigation, and, possibly, leading us on to new principles, should, in order to become plausible, "be proved consonant with some known fact." I take it that, in making tentative suggestions for the interpretation of results obtained by observation, as in the case under consideration, it is sufficient, if the hypothesis is not opposed by any known fact. I did not lay it down as a dogma that selection *must have acted* in the way stated. In fact, Prof. Weldon's original interpretation has not yet been, and never may, be disproved, and, for all we know to the contrary, selection may still be acting in the direction indicated by his measurements. Mr. Bather will see, on reference to my letter, that I advanced the idea "for whatever that idea may be worth." It appears necessary to point out that the "facts" are before us in this case; it is a question of interpretation. The difficulty raised by your correspondent is one of his own creation, and not one of mine. Where have I stated, or even suggested, that the appearance of a character which formerly was of selection value, and which now appears in the later stage of individual development, is a "universal principle"? If the suggestion which I made with reference to the interpretation of Prof. Weldon's results is sound in principle, it is obvious that it refers to a (comparatively) recent cessation of selection, and so far Mr. Bather has correctly grasped my meaning. When, however, he lays it down, on his own responsibility, that the conditions then "can hardly have been very different to now," he is laying claim to a knowledge of the past and present conditions of life and to a familiarity with the time necessary to bring about the modification of species, at which I can only stand aside with envy and admiration. If Mr. Bather really must have some "known fact" after this distinct dissociation of myself from his methods, I will refer him to those cases of mimetic butterflies which have no models. There is good reason for believing that certain butterflies which are undoubted mimics, since they depart from their allies in type of pattern, have for some unknown reason survived, while the species which they imitated have, also for unknown reasons, become extinct. The mimics still retain their mimetic pattern and colouring, but the selective process which produced this type can no longer (in the absence of the model) be regarded as in active operation. Nevertheless, the mimetic disguise is retained by virtue of heredity, and appears in the last stage of the ontogeny. Your correspondent will, I hope, pardon any apparent discourtesy if I state that the correspondence on this subject is, so far as I am concerned, now closed. I can assure him that he shall hear more about the results of Prof. Weldon's measurements at no very distant future.

R. MELDOLA.

Measurements of Crabs.

MR. CUNNINGHAM, in NATURE of October 29, raises a doubt as to the trustworthiness of the results of my measurements of crabs, on the ground that the specimens of the year 1893 had been longer in spirit than those of 1895.

The value of measurements made on animals preserved in spirit naturally depends on the animal so preserved; and to any one who is acquainted with the rigid nature of the calcareous carapace of *Carcinus mœnas*, it seems difficult to admit the possibility of distortion from such a cause. All specimens that were not quite rigid (a condition due to the animal having moulted just before capture) were rejected as a matter of course.

The fact that a deficiency in one dimension was "compensated" by an excess in the other dimension, so far from suggesting to Mr. Cunningham a suspicion of the specimens having "undergone an artificial change of shape," would, I think, have seemed not only natural, but a feature to be expected, had he realised that every crab during its growth passes through a similar change of shape, in which the relative increase in size of the one dimension (the dentary margin) is accompanied by a corresponding relative diminution in size of the other dimension (frontal breadth). The table appended to the paper in question shows that, while the dentary margin in the youngest crabs measured increased on an average from 414 thousandths of the carapace length to 498 thousandths in the adult, the frontal breadth, on the other hand, diminished in relative size from 813 thousandths in the young to 595 thousandths in the adult; so that a compensatory relation between these two parts of the hard skeleton is a normal phenomenon in these animals.

I would venture to add that observations in recent years, on the variability of both animals and plants, tend to show that species are much more unstable than was once supposed. The changes recorded in these crabs in the space of two years are very minute, but they are persistently in one and the same direction in all the twenty-six stages of growth measured. If such a rate of change exceed what we should have expected, it may be because hitherto we have had no collections of comparative facts on which to base any reasonable expectation.

H. THOMPSON.

October 30.

I AM able to offer Mr. Cunningham direct experimental evidence that the hard carapace of a young shore-crab is not sensibly distorted by immersion in spirit for six months.

I have lately had occasion to compare the mean frontal breadth in three samples of young female crabs, gathered from the same locality in Plymouth Sound. The range of size was the same in all the samples. The samples were (1) a large number of individuals, collected in 1892 and 1893, measured after immersion in spirit during a period varying between six months and a year: the mean frontal breadth in these crabs was compared (2) with that of 569 individuals, collected during the summer of 1895, and measured fresh while still wet with sea-water; and (3) with that of 595 crabs, gathered also during the summer of 1895, but preserved in spirit for about six months before measurement.

The mean difference between the frontal breadth in the spirit specimens of 1892-3 and that of the fresh specimens of 1895, was 1·47276 of Mr. Thompson's units; the difference between the crabs of 1892-3 and the spirit specimens of 1895 was 1·58992 units. The difference between the two results obtained from crabs of 1895 was therefore only 0·11716 unit—a difference so small, compared with those observed by Mr. Thompson, that it may safely be neglected, even if it be assumed to be due entirely to the spirit, and not to be within the probable error of the determination. As for the distribution of deviations from the mean in the two samples, it would take too much space to compare them in detail here; I hope to do so before very long in connection with another problem, and therefore I will only now say that the "standard deviation" (= error of mean square) of the series of fresh shells was in Mr. Thompson's units 11·7955, that of the spirit specimens being 11·9628 of the same units.

These figures seem to me sufficient to justify Mr. Thompson's conclusion; and it must therefore be held that a change, whether of oscillation or of evolution, is going on at a measurable rate among *Carcinus mœnas* in Plymouth Sound.

The very great importance of this result to all students of animal evolution is evident; for the careful study of cases in which change is actually going on so rapidly that it can be watched and measured in a reasonably short space of time will assuredly be found to give the best, if not the only clue to the process of evolution in general.

W. F. R. WELDON.

University College, London, October 31.

The X-Rays produced by a Wimshurst Machine.

IN my two papers of June 4 and June 18 respectively, I proved the existence of non-homogeneity in the X-rays, and gave a simple method of strengthening and maintaining the discharge of these rays from an ordinary focus tube by means of a conductor wrapped round the part of the tube level with and behind the kathode, and separated by a small sparking gap from either an earthed wire or the kathode's external wire loop, or the wire leading from the induction coil to the kathode itself. Since then my attention has been chiefly turned to the most remarkable results which can be attained with a Wimshurst machine, with which this paper is concerned. My Wimshurst has two 15-inch plates, and, not being of the latest type, has the old-fashioned metallic sectors and buttons, instead of the plain varnished glass disc, though I do not imagine that the results will be found materially different with the simpler, and probably better, form.

At first I drove the machine by hand, and hand driving is sufficient for the results mentioned in this paper—a most important fact, seeing that it renders unnecessary any other form of engine than the hand, and brings the copious production of any kind of X-rays within the reach of those who have neither battery nor dynamo—afterwards, for securing greater personal freedom and uniformity of turning force, I drove the Wimshurst by a small motor, an easy and most convenient plan, using a platinum electrode acidulated water resistance by which the rate of rotation is easily governed.

To me, accustomed only to the effects given by a 4½″ spark induction coil, the brilliancy of the shadows given by simply connecting my tube's electrodes to the brass knob terminals of the Wimshurst used without condensers was surprising, and the steadiness of the image a most grateful rest to the eyes. The bones seemed more transparent than I had ever seen them, and though at first I thought this might be only the effect of the lessening contrast brought about by increased general illumination, this does not prove to be the case. The two faults to be found with the Wimshurst used in this way are, first, that after a rest or complete discharge the polarity of the machine is apt to reverse, the cure being either (*a*) to completely discharge again and trust that the desired reversal will take place on re-starting, a very uncertain plan; (*b*) to interchange the wires, probably best by disconnecting them at the tube and turning the tube suitably; or (*c*) by discharging completely and starting the electrical action of the machine by holding in some position, found easily by experiment, a body electrified and whose electrification is of known sign—*e.g.* a glass rod rubbed quickly and lightly on a piece of silk or flannel. The second fault is that in this way of using the Wimshurst, whether the condensers are in circuit or not, after a time the character of the discharge is apt to alter. Beautiful patches and streaks of very bright grass-green make their appearance on the inner surface of the glass; and when one of these has formed, the X-ray discharge becomes weaker, and two or three are altogether fatal to it, even if the machine be in excellent working order. When once a patch is formed, too, it seems to cling obstinately to the place where it develops. It was suggested to me that these patches were invariably associated with bubbles in the glass of the tube, but on touching the tube lightly with a camel's-hair brush dipped in rather dry Indian ink, and thus painting over these green spots whilst they were visible, and afterwards removing the ink spot by spot and examining for bubbles, I found in many cases they were not present, and also that there were many bubbles where no fluorescent spot had been painted. These spots lie in the shortest lines which can be drawn on the glass from the kathode to the anode. They are far more numerous near the kathode, forming near it, and often gradually elongating towards the anode. Blowing gently on the middle part of the tube causes their retreat towards their birthplace, and often extinguishes them altogether. Their forms seem to be those which slightly divergent jets of matter would take if they were thrown out from different points on the sharp edges of the kathode and impinged on the inner surface of the bulb very near the kathode, exciting fluorescence so long as the matter maintained a velocity above a certain limit. If this is so, and the matter is negatively charged, and if the glass surface acts to it as a rough surface does to a stone, perhaps on account of its high electrical resistance, it is easy to see why the patches are small and slowly spread when a higher E.M.F. is used, and how it is that the dissipation of the positive charge which lies on the outside of the bulb leaves these jets of negatively electrified particles more free to take a shorter path to the anode. Thus, if they hit the glass at all, they will do so further and further from the kathode; and this explains why the fluorescent patches travel towards the anode region of the bulb, when the neighbourhood of the kathode is deprived of its positive charge by gently breathing on the glass in this part of the bulb. Similarly it also explains why the patches travel kathode-wards when the middle and anodal region is drained in any way of its positive charge, for then the attraction in the kathodal region is practically strengthened by the destruction of the attraction to other glass parts of the tube. Not only do these jets impinge on the inner side of the glass just by the kathode under ordinary circumstances, when no pains are taken to drain the external positive charge of the tube, but they are partly reflected, and, owing to the attraction of the positive charge, the path of the reflected particles is bent towards the glass surface, and in many cases a fainter patch of longer shape is formed further from the kathode, and I believe a third may be, so that the inner surface of the tube tends to become filled with patches smallest, brightest, nearest together and least elliptical, near the kathode; and becoming progressively larger, fainter, further apart, and longer in proportion the nearer they approach the anode. This has a very important application, for seeing that the formation of the patches is, by experiment, inimical to the creation of the X-rays, anything which tends to their formation must be avoided; and if, as I am convinced, they are due to the sharp edges and small irregularities of the circular kathode, no pains should be spared to give that electrode a perfect polish on the side facing the anode, and to make its edge circular, and not square, as the circular kathode's edges are in my tubes. Another way of partly overcoming this difficulty is to make the tube very wide round the kathode, or, which amounts to the same thing, push the kathode well forward into the globular part of the tube. This last is done in some tubes, I believe, with excellent results. A striking experiment is to arrange a tube and Wimshurst to give the green patches, and then to breathe rather strongly on the kathode half of the tube two or three times if necessary, and watch how the phosphorescent patches fly towards the anode as the external positive charge is dissipated and, at last, just meet behind the anode (which region becomes brightly fluorescent); finally, if the positive charge is sufficiently dissipated, part creeping and part bounding along the glass tube which, in my tube, encloses the anode's wire support, into which support, or the actual back of the anode, they finally yield their negative charge. I think that any one, who will take the trouble to make the very easy experiments here recorded for himself, will feel convinced that this is the true explanation of many of the—so far as I know—widely observed, but unexplained variations in the behaviour of the X-ray tubes, and the last experiment suggests that it would be a good thing to (i.) completely surround the anode stem and the back of the anode itself with some insulator—glass would probably prove best —and if the anode be platinum, to make the anode's edges very blunt and smooth; and it may be well, but of this I cannot feel certain without experiment, to make a small area, large enough to include the point from which the X-rays seem to emanate, rough with, say, platinum black, in order that over this area, to put it in old-fashioned language, the density of the positive electrical charge may be as great as possible.

In these ways, perhaps, the stray negative "jets" may be prevented, and a tube made to emit the X-rays more easily and steadily than any at present used.

It seems natural, from these conclusions, to suppose that pushing both anode and kathode far into the tube so that they are fairly close together, is a very good plan, for it would certainly tend to prevent leakage to the internal surface of the glass. I have heard that very excellent results have been obtained with tubes in which the electrodes are but a very few millimetres apart. The same reasoning would indicate that it would be well to make the kathode convex towards the anode, and fairly small, but not very small; for each tube there will be a special size which will be best.

Whatever the nature of the "jets" may be—and I suppose most will be inclined to believe (with Crookes) that they are particles of the residual air, for there is very little evidence of any scattering of an aluminium kathode, save just round its edge—it is clear that the effect of the external positive charge is to create a higher vacuum in the central portion by drawing the particles to the sides of the tube; and this accounts for the action of a flame on the glass bulb, which is two-fold—for it not only drives off from the sides, and possibly from the electrodes, particles of moisture or occluded gases held by some force other than electrical, but also speedily dissipates the external charge, and thus frees the "electrically bound" molecules, distributing the matter more evenly over the internal space, and thus making the passage of electricity between the electrodes easier. At the same time the phosphorescence, which is produced by their impact on the glass, becomes evenly distributed over the tube, and it is whilst hot that the X_2-rays are emitted (to which wood is transparent, but flesh opaque); and it should be particularly noted that these X_2-rays are in this case emitted when the tube offers less resistance to the electrical discharge than when the X_1-rays (which penetrate flesh, but to which bone is fairly opaque) are being emitted.

Several observers—in particular, Mr. Swinton—have mentioned that under some conditions a tube is capable of emitting rays to which bone is almost as transparent as flesh. These I shall call throughout the rest of this paper X_3, and in the experiment I am about to describe it will be found that it is possible—and, indeed, very easy—to cause a tube to emit either X_2, X_1, or X_3-rays; and not only so, but inasmuch as the change from X_2 through X_1 to X_3 is perfectly continuous, it is simplest to believe they differ, not in kind, but only in some one inherent quality, such as frequency, which varies continuously. I may say, beforehand, that the following experiment seems to me a very important one, and the study of it likely to lead to some definite conclusions as to the undulatory nature, and even evaluation of the wave-lengths of the X-rays.

Two small Leyden jars then are attached to the Wimshurst in the ordinary way; two well-coiled insulated wires, which are supported on insulating posts, terminate in brass knobs at the ends next the prime conductors of the Wimshurst, and in carefully-made small smooth loops of bare wire at the four ends. There are thus four spark gaps (and it is impossible to overrate the importance of the adjustment of these spark gaps in using the Wimshurst for this, or any other experiments where fluorescent screen or photographic effects are required—why, will appear later). For brevity I designate the spark gaps thus :—

(N) Gap between negative knob terminal of Wimshurst and coiled wire to kathode.

(K) Gap between coiled wire to kathode and the kathode external wire loop.

(P) Gap between positive knob terminal of Wimshurst and coiled wire to anode.

(A) Gap between coiled wire to anode and the anode's external wire loop.

Experiment i.—Make N and P about $\frac{1}{2}''$, A exceedingly small, and K about $\frac{1}{4}''$. The result, when the machine is being turned by hand as quickly as is convenient, is a series of discharges, during each of which the tube flashes out a brilliant, almost orange-green, giving on my fluorescent screen a light so bright as to be trying to the eyes ; the hand will show at once that X_3-rays are being emitted, and with this arrangement I have shown the ordinary shadow experiments to a large room-full at once. Three or four persons can see at the same time the back-bone and ribs of a man if a little care is taken to exclude extraneous light ; and what I expect will interest a great many people who are not scientific, I have seen (to put it popularly, though of course incorrectly) through a brick wall, *i.e.* through $8\frac{1}{2}$ inches of solid brick. To speak exactly—the rays which come through the brick are sufficiently powerful to show dullish flashes on the screen, and a piece of platinum foil placed just behind the screen is distinctly visible, though badly defined, during the flashes. It is necessary, of course, to be careful to avoid any ordinary light reaching the screen, or any X-rays from reaching it except through the wall ; but the experiment has been performed carefully many times now, and there is no doubt whatever as to the power of the rays from even my small tubes to penetrate this thickness of brick. These X_3-rays have wonderful penetrating power, and experiments with them are well worth making. The X-light is able to penetrate a little over $1\frac{1}{2}''$ of glass, and $3''$ of water easily, and $37''$ of wood.

In this experiment, unless the spark gaps are adjusted carefully (and the measurements I give are only intended as a rough guide), sparks pass along the outside of the tube in a way which at first made me anxious for the tube's life ; but so long as the tube's loops are nearer to the coiled wires than any other part of the tube, experience teaches me there is no danger. Even during the passage of these external and noisy sparks, there is a discharge inside the tube sufficient to show a faint and very transparent hand shadow on the screen, the bones being scarcely distinguishable from the flesh—these being the most transparent shadows I have yet seen.

Experiment ii.—Arrange so that A is exceedingly small, and N and P about equal, and so that the discharge by long sparks along the tube and outside it are just avoided ; then take a piece of thoroughly wet string, and fasten one end of it to the kathode loop, and the other to the end of the coiled kathode wire (a few strands of lamp-wick answer even better), and move the kathode coiled wire away from the tube's neighbourhood, carrying (of course) one end of the string with it until there is no direct sparking through the air, and all the discharge goes through the string. If the radiation from the tube be now examined by the screen with the hand held close behind it, the shadow of the flesh will be very dark indeed, and the bones scarcely visible ; in fact, it is fairly easy to secure a quite black shadow whilst the rest of the screen is brightly illuminated. These are, therefore, the X_2-rays. By shortening the string gradually the shadow changes, the flesh becoming more and more transparent, the bones' shadows remaining black for some time, until when the direct disruptive discharge through the air begins the X_3-rays are immediately restored, and the radiation penetrates easily both flesh and bone. Thus, by "loading" the circuit more or less, the character of the radiation is altered. We know that the discharge of a Leyden jar is oscillatory, and the frequency of vibration very high, also that the frequency is lowered and the oscillations damped by the use of a wet string or other resistance placed in the jar's discharge circuit ; hence it appears reasonable to suppose that it is this slackening of the electrical oscillations which produces the corresponding change in the X-rays, and that this slackening can be produced by altering resistance outside as well as inside the tube, at any point, perhaps, in the circuit, so long as the discharge is kept disruptive in character. In this experiment the discharge through the three spark gaps, and so through the whole circuit, is certainly disruptive ; but the influence of the wet string on the whole circuit, including, of course, these gaps, is shown strikingly by the altered appearance and sound of the sparks at N and P. The wet string, therefore, causes the tube to produce rays of the same kind as the heating of the tube, and if heat increases the general conductivity, it would seem that the wet string must do the same thing. It is, besides, obvious that the wet string takes the place of a rather wide air gap, and it can be very easily proved by experiment that the air gap possesses the greater resistance. Hence it might be thought that the vibrations in the case of air would be more slowly executed ; but in these experiments we have to do, not with the ordinary resistances of air and wet string, but with their resistances during the disruptive discharge ; to put it into popular language, the air can stand a great electrical stress without giving way, but when once its initial and great resistance is overcome, its resistance may be for the time very greatly diminished, so that the electricity surges backwards and forwards, it may be, many millions of times in a second ; whereas in the case of the wet string, although it opposes at first far less than the air, yet its resistance never breaks down completely, for this very reason. The air and the string may be compared in this respect to an oak and a reed in a gale of wind ; the reed, though it bends still resists, is always resisting, and the more it is bent the more it resists ; the oak stands unmoved till it is broken or uprooted, and its resistance overcome. That the oscillatory discharge is necessary for the production of the X-rays I feel no doubt, though it would be an extremely interesting experiment for any one, who had the means and leisure, to try whether they could be produced by a so-called continuous current from a battery. A very few thousands of cells would seem likely to be necessary ; but if any one should construct a tube according to the hints and instructions given in this letter, I think that the number which would be found necessary might be a good deal less. The discharge of a Wimshurst without Leydens, and with the four spark gaps nil, is still disruptive, though I expect less so when (unlike mine) the plates have no metal buttons and sectors on them ; the rotating mirror, I believe, shows that even the silent brush discharge is disruptive—certainly the thin blue sparks are so, and the discharges from the revolving plates on to the combs and between the two plates themselves, are all disruptive.

Experiment iii.—The spark gaps being arranged as in Experiment ii., instead of the wet string the secondary circuit of my $4\frac{1}{2}''$ spark induction coil was inserted, the rays given off by the tube were then X_1-rays, which gave most exquisitely bright and clear pictures on the screen, whilst at the same time the discharge through the coil gave rise to very decided Hertz effects for a considerable distance. It is clear that a rheostat of some fine wire of high resistance would be convenient to use with a tube, and that by its means we could adjust the kind of X-ray evolved very nicely.

The nature of the spark discharges at N and P during the emission of the X-rays deserves close attention. At times the spark seems like a string of equidistant silver beads strung on a bluish violet thread, and suggests stationary waves. Perhaps I may add that my work is necessarily interrupted for some weeks at least. I hope that any one who finds in this letter suggestions he would like to follow up experimentally, will not fail to carry out his wishes. The form of kathode I should recommend is a concave mirror focused on the anode, the outer rim being bent back so that the edge is well concealed behind the mirror, a section through the centre of the mirror face having a form something like a very shallow sign of Aries.

Eton College, July 24. T. C. PORTER.

Extension of the Visible Spectrum.

REFERRING to the interesting letter on the above subject, from Prof. Oliver Lodge and Mr. B. Davies, in your issue for the 29th ult., I should like to mention that I have observed a similar extension of the visible spectrum when thrown upon a fluorescent screen of barium platino-cyanide. I may add that a screen of this description becomes brilliantly luminescent when brought into the vicinity of the brush discharge from a large Wimshurst machine, or, better still, from a Tesla coil. In the latter case the fluorescent surface will become luminescent at a considerable distance from the electrical discharge, if facing the latter ; but if the screen is held with its opaque backing towards the discharge, the platino-cyanide will only luminesce if actually penetrated by the streamers of the discharge.

This screen will also fluoresce brightly at several yards distance from an ordinary Geissler vacuum tube.

A striking contrast is afforded by placing a piece of plain white paper over a portion of the screen, and observing the whole by the light either of a Geissler tube or of the Tesla brush.

Under these conditions the white paper will appear very dark, while the fluorescent surface is brilliantly luminous.

A. A. C. SWINTON.

66 Victoria Street, London, S.W., November 3.

IN continuation of our etter of October 29, we find that a reflexion grating does not show the bands so well as a quartz prism, because metals, *e.g.* silver-on-glass, do not reflect all this kind of light completely except at grazing incidence. The furthest band shown by a Rowland grating at incidence 45° has wave-length 2200 tenth-metres, whereas the extreme ultra-violet usually quoted (the Fraunhofer line U) is 2948 tenth-metres, and the bright bands shown by quinine are about 3250 and 3830 respectively. With a quartz prism the fluorescence caused by light of shorter wave-length than 2200 can be seen. But it is quite possible that Sir George Stokes in 1852 saw as far as we can see to-day.

OLIVER J. LODGE.

November 7. BENJAMIN DAVIES.

Osmotic Pressure.

As Mr. Whetham has called attention in your columns to my attempt to give a mechanical hypothesis for osmotic pressure, in the October number of the *Philosophical Magazine*, perhaps you will allow me to give some explanation of my somewhat faulty use of the term "dissociation hypothesis," which, as Prof. Ramsay has pointed out to me, may easily be misunderstood. I have used the term to signify not the separation of the ions in electrolytes, but rather the freedom of the solute molecules in non-electrolytes, and of the atoms in electrolytes—their dissociation, in fact, from the molecules of solvent. It appears to me that in some statements of the facts of osmotic pressure, the idea is strongly suggested that the molecules or atoms of the solute are moving about among the molecules of the solvent, and, as far as pressure at any rate is concerned, dissociated from them, and producing an independent effect, the osmotic pressure being directly due to the solute. My aim is to show that we may more reasonably account for the facts by supposing that the solute molecules or atoms are associated with the solvent molecules, entering into some kind of more or less unstable combination with them, and that the solution is not to be regarded as consisting of two parts producing independent pressures. The extra osmotic pressure is, of course, due to the solute in one sense, in that it would not exist without it; but it is an indirect effect, due to the modified compound molecules formed. The first effect is a decrease in "mobility" of the solution, so that the exchange in the two directions through a semi-permeable membrane is unequal, and it is only rendered equal when the solution is put under the extra pressure which we call osmotic pressure.

Mr. Whetham has shown, in a very simple way, that my hypothesis does not necessarily conflict with the facts of electrolysis, and that the idea of dissociation of the ions *from each other* may easily be reconciled with it.

J. H. POYNTING.

Mason College, Birmingham, October 31.

"Purple Patches."

I SHOULD be very glad if I could obtain information as to the cause and nature of certain "purple patches" which I have noticed from time to time for many years past, but have been unable to get explained. The patches in question occur during, or immediately after, rain, on the pavement or roadway; dashes of vivid purple, or rather violet, varying in size from small splashes or drops to patches as large as the palm of one's hand, but most commonly they are about the size of a shilling. When quite fresh, sometimes a little clot is observable in the centre of the splash. Sometimes I find one patch completely isolated, sometimes two or three in close proximity; sometimes, again, numerous little drops scattered over a certain space; once I counted twenty or thirty tiny dashes in about ten yards of pavement. When quite wet the violet colour can be rubbed up with a handkerchief or paper, which it stains as with "aniline purple" dye, as it does the pavement, and when once dry it is quite inerasible, and lasts till it is worn away by exposure, or the feet of passers-by. I observe it to occur chiefly during warm rain after a dry or cold spell; *never during* dry weather, whether in summer or winter. During the past hot summer there was none to be found, but directly the weather changed in July, I saw it in various localities. This was also the case in the long cold winter of 1895, when on the breaking up of the frost there were plentiful patches to be seen up and down the streets; there was also a complete absence during the following summer, till the drought gave, and then again I found this appearance recur. I naturally observe it most in Bath, where I live; but it is not at all confined to one place or situation. I have found good specimens at such widely different places as the doorway of a hotel at Oban; the Castle Hill, Edinburgh; railway platform at Morecambe; doorstep at Windermere; in streets and roads at Cambridge, Bude, Penzance, St. Ives, Clevedon; once in a London street (Pall Mall East), and once some was found in a cold water bath.

I have from time to time made inquiries from various people who I thought would know, but have not been fortunate enough to meet any scientific person who has observed it. But one learned professor to whom I described the "patches," suggested whether "purple bacteria" would prove a solution to the mystery, and recommended me to inquire through the medium of your columns. I should be much obliged if some one would enlighten me, or mention some authority to whom I could refer.

A. PEDDER.

13 Somerset Place, Bath, October 27.

Note on "Plasmodiophora brassicæ."

ALTHOUGH it is well known that *Plasmodiophora brassicæ* attacks the great majority of cruciferous plants, yet no instance of the common Shepherd's purse (*Capsella bursa-pastoris*, D.C.) being attacked is recorded in this country. Thus Massee (*Proc. Roy. Soc.*, vol. lvii.) quotes the Shepherd's purse as being reported by Halsted to be attacked in America, but says "It has not been observed to be diseased in this country, although one of our commonest weeds." During the past summer my attention was drawn to some plants of *Capsella* with swollen roots, growing in a sandy field near Coventry, on land upon which crops of swedes and turnips were grown in the usual rotation, and I had no difficulty in finding several additional specimens. These roots, on examination, were found to have the characteristic plasmodium in their cells. The Shepherd's purse must now be numbered among the plants in this country which provide a home for *Plasmodiophora*, and probably help it to maintain its existence in the ground from year to year, thus proving a possible source of injury to cruciferous crops.

The length of time for which *Plasmodiophora* can retain its vitality in the soil in the absence of any cruciferous plants, is still a matter of uncertainty. In order to ascertain this, in November 1893, I established a series of experiments (fully described in my annual report to the Newcastle Farmers' Club, 1895), intended to extend over a period of six years. In these experiments, six beds (A–F) and six large 18-inch flower-pots (A–F) were prepared, and each strongly infected with pieces of turnip badly diseased with "Finger-and-Toe," one bed and one flower-pot being sown with turnips each successive spring. The beds and pots acted as duplicate experiments, and the soil in both remained unmanured, and was carefully guarded from the intrusion of *Plasmodiophora*, while all cruciferous plants were rigidly excluded.

In 1894, in both pot A and bed A "Finger-and-Toe" appeared; in 1895, in the pot B "Finger-and-Toe" was found upon four plants out of six; and in the bed B, 8 per cent. were diseased. In 1896 the same result was strikingly shown; after a period of three years, the bed C and pot C were still found to be diseased, four out of five plants being affected in the latter, and 10 per cent. in the former. Massee had previously shown that the germs of disease retain their vitality for two years, and my experiment this year shows that this period can be increased to at least three years.

M. C. POTTER.

Durham College of Science, Newcastle-upon-Tyne, October 24.

Sparrows and Wheat.

IN vol. vii. part iii. p. 522 of the *Journal* of the Royal Agricultural Society it is stated that, in the Leicester district, Rivett's wheat is much grown, the reason being that sparrows do not attack it, while they do other varieties. Can any of your readers assign a cause for the exemption from attack of this particular variety? It is most curious if correct; and the authority quoted apparently is a good one.

F. G. BROOK-FOX.

Port Navis Cove, Penryn, Cornwall, November 1.

THE NEWEST GERMAN POLYTECHNIC.

WHETHER there is any sufficient ground for the opinion that Germany, by reason of her superior educational system, is gaining at our expense an undue share of trade and commerce, is a question on which statistics of exports and imports necessarily throw much light, although they fail to completely satisfy those who have watched the recent rapid development of German enterprise. Be that as it may, there can be no doubt as to the efforts which Germany is making to improve her trade by taking advantage of every application of science that may seem likely to help in developing her industrial operations. We are sometimes apt to think that, whilst we are gradually improving our educational machinery at home, Germany is standing still. But this is not so. On the contrary, experience seems to have strengthened her belief in the value of the higher scientific education, and there is no unwillingness on the part of the several German States to incur the expenditure needed to render its benefits readily accessible. The new Polytechnic at Darmstadt is a case in point.

For many years Darmstadt has had in the *Kapellplatz* a technical high school, which had gradually grown in size till it occupied eight separate buildings. Latterly, however, it became too small for the increasing number of its students, and the question of its further extension was carefully considered. The immediate cause, however, of the erection of a new building, was the recent rapid development of the electro-technic school, which, commenced on a very small scale in 1882, has now become the most important section of the new institute. It is interesting to note that we in England were the first to establish a school for the study of the technical applications of electrical science. For a short time the Finsbury College had no rival, and in 1882 the appliances in German schools for practical instruction in electrical engineering were meagre in the extreme. The state of things now is very different, and the institution at Darmstadt is a good example of recent progress.

The necessity for extending the old technical school was soon recognised by the State authorities, who at once offered to provide £16,000 for the erection of special electro-technic laboratories, and £11,250 for equipment.

Simultaneously with this offer came a suggestion from the city of Darmstadt to take over the old buildings in which the Polytechnic had been housed, and to contribute towards the erection of a completely new school the sum of £60,000, it being understood that with the payment of this amount all duties and obligations of the city towards the school should cease. This generous offer was at once accepted by the State, and a site measuring about 24,000 square yards was provided in the beautiful gardens adjoining the city. The preparation of the plans was entrusted to the official State architect, with whom, however, were wisely associated the two Professors of Architecture, Dr. Wagner and Dr. Marx, who had been connected with the school for over twenty years, and were thoroughly familiar with the requirements of the different faculties, and were able easily to ascertain the wants of their several colleagues.

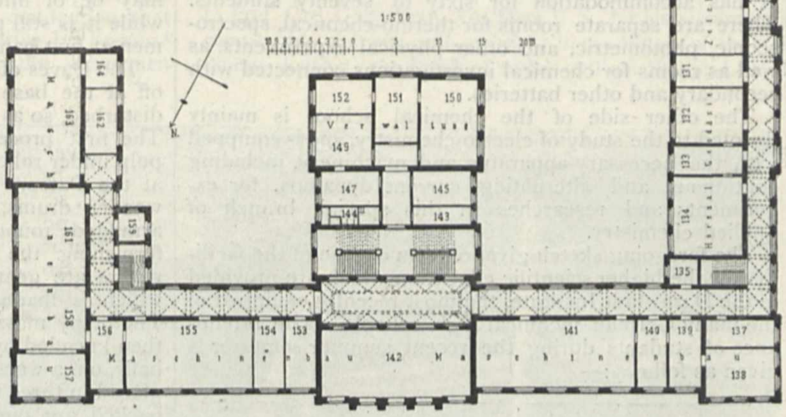
The Darmstadt Polytechnic—Main Building.

The main building, as shown in the sketch, is three-storeyed, and has a north frontage. There are three wings at right angles to it, which are given up to the teaching of mathematics and some branches of natural science, and to the schools of architecture and engineering. In these wings first year's students receive their instruction. Opposite the front entrance of the building, and on the other side of the road, are two separate institutes—one of which contains the physical and electro-technic schools, and the other the chemical laboratories and class-rooms. In the rear of the main building is the engine-house, from which electric light and power and heat are supplied to all three buildings.

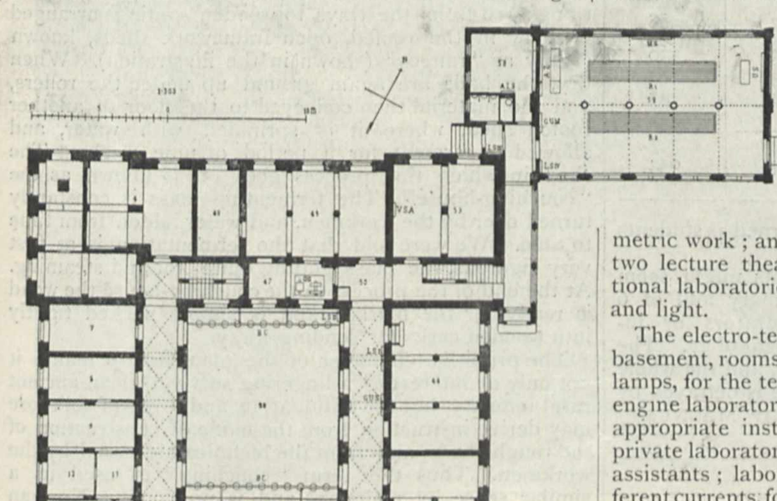
In the fitting and equipment of the several laboratories, class-rooms, and lecture-rooms, all the professors lent their aid, each advising with respect to his own particular department; and to the expert assistance thus obtained is undoubtedly due the completeness and the economy effected in the details of all the arrangements for practical instruction and experimental work. The building was begun in February 1893, and was completed in October 1895. The cost of the entire institute, including fittings, furniture, machinery and apparatus, did not exceed £120,000. The cost of the main building alone was £46,485, which works out to about 5¼*d*. a cubic foot; and this gives some idea of the apparently cheaper rate at which such buildings are erected in Germany.

The main building contains the usual series of drawing offices—a special feature of every technical college in Germany—rooms for collections of various models, the engineering laboratories, class-rooms, lecture-rooms, a large hall, a library, and the administration offices. The arrangement of rooms on the first floor, mainly devoted to mechanical engineering, is shown on the annexed plan.

The most interesting department of the institute is undoubtedly the building devoted to the physical and electro-technic schools. This is divided into two distinct sections—the one for instruction in physics proper, including electricity, and the other for the technical applications of electricity. In the annexed plan of the ground floor, the rooms on the left of the central court belong to the physical, those on the right, including the annex containing the dynamo and motor machinery, belong to the technical section. Each section contains workshops for the making and the repairing of apparatus, but these shops are not used by the students. Indeed, workshop training does not, even now, form any part of the curriculum of students at a technical high



Main Building—First Floor



Ground Floor Plan of adjoining Physical and Electro-technic Institute.

school. They are required however, during their course of study, to spend parts of their long vacations in engineering shops; and no difficulty is found in obtaining for students admission to the State railway works, or to the machine shops of well-known electrical firms.

The apparatus of the two divisions of the physical and technical institute is necessarily, to some extent, duplicated, and the more so, as the schools are kept quite distinct; but there are some advantages in the two departments being housed in the same building. Each department contains separate laboratories carefully fitted for experimental work, and provided with the necessary apparatus and appliances for accurate measurements. In the basement of the physical department is a room specially fitted with double walls for experiments requiring uniform temperature, rooms for chemical and photographic work, an engine-room containing a gas motor, dynamos, and other machines. On the ground floor are separate laboratories for the Professor of Physics, Dr. Schering, and for the chief assistant, a laboratory for magnetic experiments free from iron fittings, and other separate laboratories for galvanic, optical, and photometric work; and above this floor are the balance rooms, two lecture theatres and preparation rooms, and additional laboratories for exercises and experiments in heat and light.

The electro-technic section of this building has, on the basement, rooms for accumulators, for testing arc and glow lamps, for the testing of cables, besides the dynamo and engine laboratories. These are all carefully equipped with appropriate instruments and apparatus. Above are the private laboratories of the Professor, Dr. Kittler, and of his assistants; laboratories for measuring the strength of different currents, for magnetic investigations, for determining resistances, coefficients of induction, &c. The arrangements for lighting the lecture-rooms, and for the conveyance of currents from different combinations of batteries are very complete, and give evidence of the thought and care expended on the equipment of the school. To each laboratory separate currents are supplied from the galvanic batteries and dynamos, from the main current machine, from the accumulators, and from the central electric station in the rear of the main building. The network of wires, which can be connected in different combinations for experimental purposes, has been fitted by Messrs. Schuckert, of Nürnberg, in whose works are found a large number of the students who have received their training at this school.

There are already over three hundred students in this one department of the Darmstadt High School, and the building, which was completed in October 1895, is now being extended. The course of instruction covers four years: the first year is spent in the main building, in a general course of scientific study; the second is given up to physics, and the last two years are devoted to practical exercises in the electro-technic institute.

The chemical school is housed in another separate building, which also consists of two departments—the one for the study of pure chemistry, and the other for the study of chemical technology, electro-chemistry and pharmacy. The department for pure chemistry consists of three large laboratories for analysis and preparation work, and of a number of smaller laboratories for special researches. It has accommodation for sixty to seventy students. There are separate rooms for thermo-chemical, spectroscopic, photometric, and other physical experiments, as well as rooms for chemical investigations connected with secondary and other batteries.

The other side of the chemical school is mainly devoted to the study of electro-chemistry, and is equipped with the necessary apparatus and machinery, including continuous and alternating current dynamos, for experiments and researches in this special branch of applied chemistry.

The foregoing sketch gives only an outline of the facilities for the higher scientific education which are provided in the Darmstadt Institute, the most recently equipped of the many German technical high schools. The attendance of students during the recent summer semester is given as follows:—

Departments.	Regular students.	Occasional students.	Total.
Architecture	74	13	87
Engineering and machine construction ...	351	37	388
Electro-technology ...	307	23	330
Chemistry	89	13	102
General science	29	18	47
	850	104	954

In the chemical department, 39 are returned as students in the electro-chemical section.

The teaching staff for these 954 students might seem to us excessive. It consists of 27 ordinary and of 6 extraordinary professors, of 22 demonstrators or instructors, and of 22 assistants, making a total of 77. The students' fees vary from £8 to £12 a year, and the whole of the deficit on the cost of maintenance is defrayed by the State.

PHILIP MAGNUS.

A VISIT TO AN ENGLISH WOAD MILL.

A REFERENCE to any old gazetteer under the name Wisbech will show that this town was once an important centre of the English woad industry. It is not generally known, however, that woad is still grown and worked up in a few localities, and it was with some surprise that we learnt that the processes connected with the manufacture might be seen in operation at Parson Drove, near Wisbech, at the present time. There are said to be three other places where the plant is cultivated and worked up for use by dyers—one near Boston and two near Holbeach, in Lincolnshire; but at these centres the introduction of steam power has destroyed the primitive character of the manufacture. As an interesting survival of the past, the mill at Parson Drove is well worthy of a visit.

It is hardly to be expected that a feeble tinctorial substance, such as woad, can retain a permanent footing as an English product in view of the circumstance that it has to compete with indigo, as well as with its modern coal-tar substitutes. The thought that this old-time industry, like the potash-making in Essex,[1] is sooner or later destined to become extinct, has led us to place upon record the information which we gathered during a visit to the Parson Drove mill in July of this year. We may add that descriptions of this mill were given in the *Gardeners' Chronicle* in 1881[2] and 1882; but, as we obtained later and more detailed statements on the spot, concerning the actual operations as now conducted, it may be of interest to chronicle the facts once again while it is still possible to get particulars from the woadmen at first hand.

The leaves of the plant (*Isatis tinctoria*) are wrenched off at the base by the pickers, the root being left undisturbed, so as to permit the growth of a second crop. The first process consists in crushing the leaves to a pulp under rollers. The latter, of which there are three at the Parson Drove mill, are hollow, slightly conical, wooden drums, with about two dozen iron cross-bars arranged round the circumference, these iron bars furnishing the effective crushing edges. The three rollers are geared to a long projecting horizontal pole, which is made to move round by means of a horse. The pulpy mass resulting from the crushing operation is then kneaded by hand into balls, about the size of cricket-balls, on a wooden stage, the balls, when made, being placed in three rows on wooden trays, which, as they are packed, are pushed up a sloping plank till high enough to go on to the head of a man who stands at the end to receive them. Each tray, as it is delivered, is carried to the drying sheds. The balls are allowed to dry in the air for about four weeks, and are for this purpose transferred from the trays to wooden gratings arranged in tiers in the roofed, open framework sheds, known locally as "ranges" (shown in the illustration). When dry, the balls are again ground up under the rollers, and the material then conveyed to the floor of another roofed shed, where it is sprinkled with water, and allowed to ferment for a period of nine weeks. The shed in which this process goes on is known as the "couching-house." The fermenting mass is constantly turned over by the workmen, and water added from time to time. We were told that the fermentation is at first very vigorous, the mass getting quite hot and steaming. At the end of the process in the couching-house the woad is ready for the market, and is simply packed tightly into wooden casks for sending away.

The primitive character of the manufacture makes it not only of interest as a lingering survival of an ancient rural industry, but the antiquarian and lover of folk-lore may derive instruction from the mode of construction of the rough sheds, and from the technicalities used by the workmen. Thus the term "couching" is used in a similar sense by maltsters, and is no doubt a Norman survival (Fr. *Coucher*); the sloping plank is called the "firm" (? form), and the tray on which the pulp is kneaded is known as the "balling-horse." The balls were formerly dried on wattles, known as "fleaks," a term apparently identical with the word still used for hurdles in Scotland; but these are no longer used at Parson Drove. The central circular shed containing the rollers is built of wooden planks and posts, and thatched with a conical roof; the lateral couching-house is constructed of thick turf walls, with the slabs arranged in a peculiar herring-bone form, and also roofed with thatch.

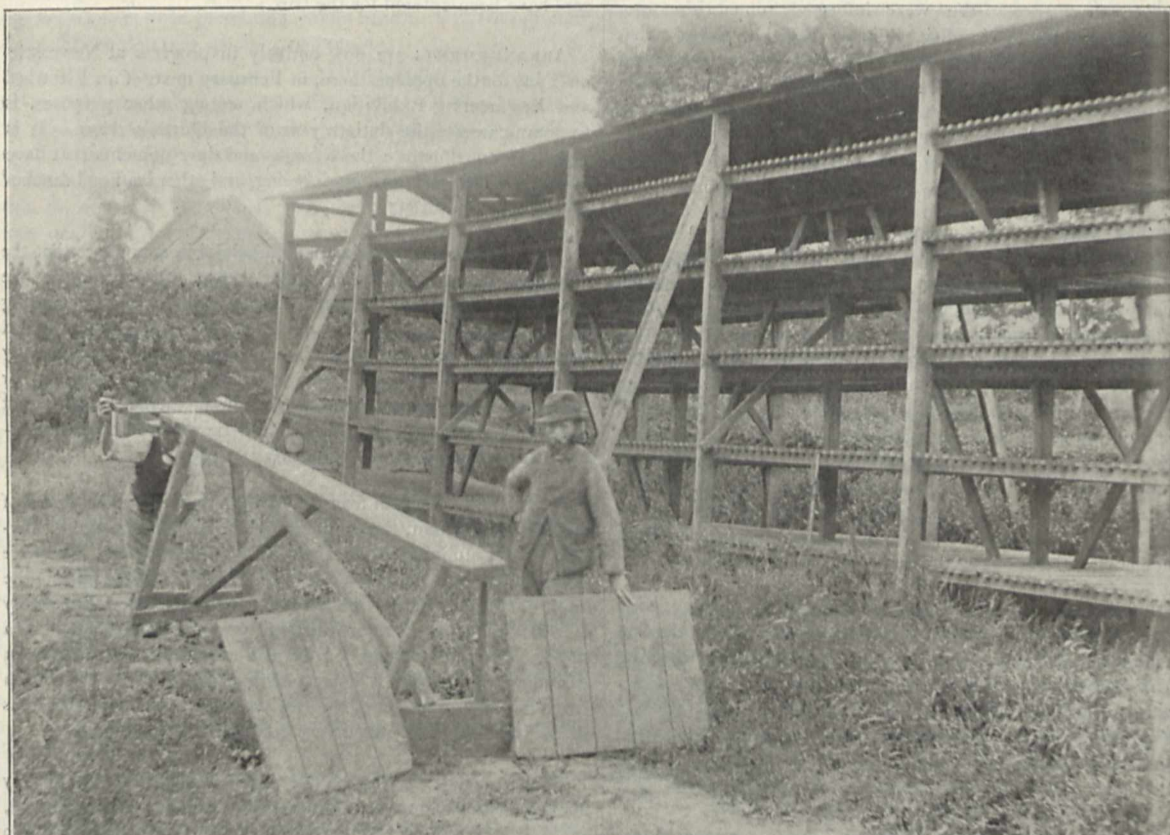
[1] See a paper by Henry Laver in the *Essex Naturalist*, vol. ix. p. 119.

[2] The writer of this article acknowledges, as the source of his information, a recent paper in the *Friends' Quarterly Examiner*. An interesting popular account of the mill appeared in *Aunt Judy's Annual* volume in 1883.

The whole construction was evidently framed with a view to cheapness and simplicity, so as to be easily removable. In the palmy days of the industry the sheds were not permanent erections, but were moved about from one place to another, so as to be near the crops.

We content ourselves with recording the bare facts without comment or criticism. Any science that lurks behind this ancient manufacture has been found out empirically, and handed down by tradition from a remote past. The imaginative person may indulge his fancy by carrying back the woad industry to that period when the early inhabitants of this country furnished that solitary scrap of personal information which is still the historical stock-in-trade of the average schoolboy. It may be well, however, to point out in this connection that *Isatis tinctoria* appears not to be a native of Britain.[1] We were told that in former times the woad-men were limited to certain families, and that they had traditional chants of their own; but these are passing into oblivion, and we were unable to ascertain the words.[2] The object of drying the pulp first, and then wetting it again before allowing it to ferment, is not at first sight obvious, nor could we learn why this practice has been found advantageous. The fermentation itself is no doubt a zymolytic decomposition of glucosides. The use of woad as a source of indigo is now very limited, being confined to some of the old-fashioned Yorkshire dye-houses, where it is used in conjunction with indigo in the so-called "woad vat," a description of which will be found in any work on dyeing.

FRANCIS DARWIN.
R. MELDOLA.



Woad Mill at Parson Drove. Two "balling-horses" are shown in front; between them is the "firm," from the further end of which a man is lifting one of the trays on which the balls are carried to the "ranges"; the latter are shown on the right

[1] In the "Flora of the British Islands" (ed. 1870), Hooker says: "The ancient Britons stained themselves with this plant; later the Saxons imported it." Can it be that even at that remote period the British colour industry could not hold out against continental competition?

[2] A verse is recorded by Miss Peckover in the article in *Aunt Judy's Annual* volume for 1883, p. 549.

NOTES.

THE Royal Society's medals have this year been adjudicated by the President and Council as follows:—The Copley medal to Prof. Carl Gegenbaur, For. Mem. R.S., for his researches in comparative anatomy, and especially in the history of the vertebrate skeleton; the Rumford medal to Prof. Philipp Lenard, and also to Prof. Wilhelm Conrad Röntgen, for their investigation of the phenomena produced outside a highly exhausted vacuum tube through which electrical discharge is taking place; a Royal medal to Sir Archibald Geikie, F.R.S., on account of the great value and importance of his many original contributions to geology; a Royal medal to Prof. Charles Vernon Boys, F.R.S., for his invention of quartz fibres and investigation of their properties, his improvement of the radio-micrometer and investigations with it, for developments in the art of instantaneous photography, and for his determination of the value of the constant of attraction; the Davy medal to

Prof. Henri Moissan (of Paris), for the isolation of fluorine and the use of the electric furnace in the preparation of refractory metals; the Darwin medal to Prof. Giovanbattista Grassi (of Rome), for his most important discoveries, especially on matters directly related to Darwin's speculations. Her Majesty has signified her approval of the award of the Royal medals.

WE find the following piece of news in the *Pall Mall Gazette*:—"Prof. Koch and Dr. Kohlenistock, the German bacteriological experts, are to leave Southampton on the 14th inst., in the *Dunottar Castle*, for the Cape. They are being sent out by the German Government to inquire into the plague of rinderpest, and to report what measures are best in their opinion to prevent it spreading to the German South-west African Colonies. The Cape Government is giving every facility to the Commission." Nothing could better show the vast difference which exists between the British and German Governments in relation to all questions of science. We were informed some time ago, by one upon whom implicit reliance can be placed, that some years ago, long before the devastating rinderpest crossed the Zambesi, the Foreign Office was warned of its serious nature, and it was pointed out at the same time that the proper step to be taken was to send out a competent man of science to investigate it, in order that some means might be found to stop it. The Foreign Office declined to take any action in the matter.

AT first sight it might appear that such a question as the election of the President of the Royal Academy is beyond our purview; but there is one point about it, which makes it needful for us to refer to it. The Royal Society and Royal Academy are the bodies in this country to whom is entrusted the duty to look after the highest interests of science and art respectively. It is necessary that in the case of both bodies the office-bearers should be chosen among those whose leadership is beyond question. The distinct affirmation by the Academicians by their selection of the new President, that excellence in art is the chief point they have to consider, should not be without reflex action in our scientific bodies, first among which is our Royal Society. With some of the minor societies excellence in science is oftentimes one of the last things to be considered.

THE following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1897 at the anniversary meeting on November 30:—President: Sir Joseph Lister, Bart. Treasurer: Sir John Evans, K.C.B. Secretaries: Prof. Michael Foster, Prof. Arthur William Rücker. Foreign Secretary: Dr. Edward Frankland. Other names of Members of the Council (the names of new members are printed in italics): *Prof. William Grylls Adams*, *Prof. Thomas Clifford Allbutt*, *Prof. Robert Bellamy Clifton*, *William Turner Thiselton-Dyer, C.M.G.*, *Prof. James Alfred Ewing*, Lazarus Fletcher, Dr. Walter Holbrook Gaskell, *Prof. Alfred George Greenhill*, Dr. William Huggins, Prof. Charles Lapworth, Major Percy Alexander MacMahon, R.A., *Prof. Raphael Meldola*, *Prof. William Ramsay*, *The Lord Walsingham*, *Prof. Walter Frank Raphael Weldon*, Admiral William James Lloyd Wharton, C.B.

SIR JOSEPH LISTER and Prof. Michael Foster have been elected honorary members of the Asiatic Society of Bengal, as successors to Huxley and Pasteur.

PROF. PENZIG, of Genoa, has started on a botanical expedition to Buitenzorg, Singapore, and Ceylon. The editorship of *Malpighia* is in the meantime undertaken by Prof. Pirotta, of Rome.

PROF. HUGO DE VRIES has been appointed Director of the Botanic Garden in Amsterdam, in the place of Dr. Oudemans.

THE German Fisheries' Association has offered a prize of 600 m. for the best essay on the history of development and the vital conditions of *Leptomitus lacteus*, with especial reference to its appearance and disappearance in impure water. The essays are to be sent in to Prof. Weigelt, 90/91 Zimmerstrasse, Berlin, S.W., by May 1, 1897.

THE Republic of Mexico, at the beginning of October, adopted the metric system of weights and measures for use throughout the country as a legal system.

A RUN of motor cars from London to Brighton will take place on Saturday, November 14, when the new regulations with respect to the use of light locomotives on highways come into force. The vehicles will assemble at the Hôtel Metropole, and are expected to start at 10.30 a.m., Mr. Henry J. Lawson, President of the Motor Car Club, leading the way. Fifty-four cars have been entered for the trip.

ARRANGEMENTS are now actively in progress at Newcastle-on-Tyne for the opening there, in February next, of an Electrical and Engineering Exhibition, which, among other purposes, is to commemorate the sixtieth year of the Queen's reign. It is proposed to illustrate the changes and developments that have taken place in electrical, engineering, and other leading branches of industry since 1837.

THE College of Physicians of Philadelphia announces that the next award of the Alvarenga Prize, being the income for one year of the bequest of the late Señor Alvarenga, and amounting to about 180 dollars, will be made on July 14, 1897, provided that an essay deemed by the Committee of Award to be worthy of the prize, shall have been offered. Essays intended for competition may be upon any subject in medicine, but must not have been published, and they should be received by the Secretary of the College on or before May 1, 1897.

A REUTER telegram from Stockholm announces the death of Prof. Hugo Gylden, the eminent astronomer, at the age of fifty-five. After studying at the University of Helsingfors, his native town, he entered the Observatory at Pulkova, where he was the pupil of Struve. In 1871 he became Director of the Observatory in Stockholm, and, after thirteen years, was appointed to a similar post in Göttingen. He was a member of the Stockholm Academy of Science, a corresponding member of the French Institute, and an officer of the Legion of Honour. His numerous works have made his name very familiar to astronomers.

THE opening meeting of the 143rd Session of the Society of Arts will be held on Wednesday evening, November 18, when an address will be delivered by Major-General Sir Owen Tudor Burne, K.C.S.I., Chairman of the Council. The subject of the address will be "India, its Arts, Manufactures and Commerce." At the subsequent meetings before Christmas, the following papers will be read:—"Recent Developments in Mechanical Road Carriages," by W. Worby Beaumont; "The Teaching of Economics," by W. A. S. Hewins; "Mining at Great Depths," by Bennett H. Brough.

THE *Kew Bulletin* announces that the Government of Zanzibar have decided to appoint a Director, and have selected Mr. Robert N. Lyne for the post. The new Director informs Mr. Thiselton-Dyer that the object of the Government in creating the post is to improve, where possible, the methods under which the agriculture of the country is now carried on, and to endeavour by experiment to discover some new product that may to a certain extent take the place of cloves. The Government des're that the work so admirably begun by Sir

John Kirk when he was Consul General there, and since interrupted, may be continued.

AT a meeting of the Royal College of Physicians held on Friday last, a Committee was appointed to consider and report to the college on the desirability of including the subject of bacteriology in the course of study and examination for the college licence. The members of the Committee are—Dr. Pavy, Dr. Church, Sir Dyce Duckworth, Dr. Ord, Dr. Poore, and Dr. Washbourn. At the same meeting, Sir William Roberts was announced as the Harveian Orator for 1897; and it was decided that the sum of 1000*l.*, presented by Captain E. Wilmot Williams, with the object of perpetuating the memory of the late Dr. Bisset-Hawkins in connection with the college, be utilised for the purpose of establishing a gold medal to be presented by the college. The medal will be awarded triennially to some duly-qualified medical practitioner who is a British subject, and who has during the preceding ten years done such work in advancing sanitary science, or in promoting public health, as in the opinion of the college deserves special recognition.

A PRIZE of £50, to be called the Welby Prize, is offered for the best treatise upon the following subject: "The causes of the present obscurity and confusion in psychological and philosophical terminology, and the directions in which we may hope for efficient practical remedy." Competition is open to those who, previously to October 1, 1896, have passed the examinations qualifying for a degree at some European or American university. The Committee of Award will consider the practical utility of the work submitted to them as of primary importance. The essays, which may be written in English, French, or German, must be type-written, and extend to at least 25,000 words. They should be headed by a motto, and accompanied by a sealed envelope containing the name of the writer. Manuscript from America should be sent to Prof. E. B. Titchener, Cornell University, Ithaca, N.Y., and must reach its address not later than October 1, 1897.

MR. FRANCIS GALTON traces, in the *Fortnightly Review*, a hypothetical discovery of a system of signalling from the planet Mars, and shows how a succession of signals, divided into dots, dashes, and lines of light according to their duration, might be interpreted. Savages can communicate with one another by gestures, deaf mutes by the movements of the lips, and criminals by alphabetical tappings upon the walls of their cells. Mr. Galton shows how, by a kind of Morse code, the Martians could first signal to us the summation of numbers, such as $2 + 3 = 5$, $3 + 3 = 6$, and also the results of multiplication and division. He does not consider the view of the fourth dimensionists, that possibly there are worlds where $2 + 2 = 3$. After the arithmetical rules had been signalled, the supposition is that the relative distances of the planets from the sun were flashed to the earth; then the relation between the circumference and diameter (π); then the area of the circle (πr^2); then the names of a number of regular polygons, with the number of sides and area of each. Granting that the Martians were able to make themselves clear so far, they could develop a system of picture-writing. With three varieties of signal, twenty-seven combinations would be possible, and each could represent a particular word or sign. Each side of a polygon with twenty-four sides could, therefore, have a name of its own, and each one would have a definite bearing or direction with reference to the others. All is now plain sailing. The Martians signal the symbols of a number of sides, and, as each is received, a line is drawn in a particular direction. From the formula thus obtained, a picture can be reproduced, as Mr. Galton showed at a Royal Institution lecture in 1893 (see NATURE, vol. xlvii. p. 342). The conclusion is that intelligible messages are possible between planets sufficiently near together for signalling purposes.

IN our last issue appeared an abstract of the presidential address delivered by Mr. J. Wolfe Barry, C.B., F.R.S., to the Institution of Civil Engineers, which now numbers nearly 7000 members of all classes. Under the altered by-laws the session of the Civil Engineers commences on the first Tuesday in November, and lasts exactly six months, ending on the last Tuesday in April. By a supplemental Charter, obtained in March last, the number of the Council has been extended in order that all engineering interests, both at home and in the colonies and India, may be fully represented on that body, while corporate members have been given the power of voting for the election of the Council without the necessity of being present at the annual general meetings, a condition which had practically debarred the majority of the members from voting at all. During the past year some important changes in the staff of the Institution have taken place. Mr. James Forrest, who has been connected with the society for fifty-four years, has retired from the post of Secretary, his successor being Dr. Tudsbery. Mr. Forrest has been appointed Honorary Secretary; while the retiring Honorary Secretary, Dr. W. Pole, F.R.S., has been, by a special vote of the Institution, enrolled in the distinguished list of Honorary Members. The following medals and premiums have been awarded by the Council to the authors of papers dealt with during the session 1895-96:—Telford medals and premiums to H. Riall Sankey, late Captain R.E.; Prof. J. A. Ewing, F.R.S., J. O. Arnold, G. H. Hill, and F. E. Duckham; Telford medal and Manby premium to the Hon. R. C. Parsons; Watt medals and Telford premiums to Jeremiah Head, Dr. E. L. Corthell, and C. F. Jenkin; George Stephenson medals and Telford premiums to G. F. Deacon, W. Adams, and W. F. Pettigrew; Telford premiums to John Dewrance and A. F. Bruce; Manby premiums to B. Donkin and Alan Brebner; Crampton prizes to Hammersley Heenan, W. Gilbert, T. Wrightson, H. F. Parshall, and D. T. Jarintzoff, Imperial Russian Navy; Trevithick premiums to A. W. Szlumper and C. A. Rowlandson; and Miller prizes to W. O. Leitch, jun., A. S. Butterworth, E. S. McDonald, S. Thow, J. Scott, J. Andrew, and M. De Ville.

MR. SHELDON JACKSON has filed, at Washington, a report of the condition of affairs in Alaska. Among items of interest are the statement that the Government herd of reindeer has increased in number to 1091; of which 337 are young of the present year, that have not attained sufficient maturity to enable them to endure the rigors of winter. The weather last winter was exceptionally severe, a temperature of $-87°$ having been noted at one point, and $-20°$ having been sustained for a period of several weeks.

NUMBERS of swallows were seen skimming over the river Test, at Mottisfont, Hampshire, on Monday, November 2. Mr. W. C. Worsdell, who imparts this information, says they sometimes rose forty or fifty feet in the air, but for the most part they remained near the surface of the water. Probably this behaviour at a late season induced the old naturalists to think that swallows hibernated beneath the water. On October 27, Mr. Worsdell observed house-martins flying to and fro over Kew Gardens; and on November 1, they were seen flying high in air above the New Forest. Mr. S. Stainer, writing from Southampton, says he saw five swallows briskly flying a little before sunset on November 6.

A RAPID photographic printing machine was shown by Mr. Friese Greene at the Royal Society Conversazione in May last (see NATURE, vol. liv. p. 37). A roll of rapid bromide paper was fed in at one end of the machine, and finished prints were turned out at the other end at the rate of two or three thousand an hour. In a recent number of the Russian *Photographic Review*, a description is given of the establishment of Arthur Schwartz, at Berlin, where illustrations for magazines are printed by this method. The bromide paper generally employed is 100 centimetres wide and a kilometre long. Sometimes a width of 450 centimetres is used, and full-size photographs of men on horseback have been produced. If the negative from which prints are required is much less than 100 cm. wide, a row of them is arranged; and in this way forty thousand copies of cabinet photographs have been printed and finished ready for distribution in ten hours. Our Russian contemporary gives a photograph printed by the new method, and it is really a very brilliant picture. It is stated that the twelve hundred copies required for the embellishment of the *Review* were absolutely identical in tone and detail.

IN a recent paper communicated to the Academia dei Lincei, G. Folgheraiter describes a curious method he has devised for obtaining the approximate value of the dip in ancient times, and hence deducing the value of the secular variation. In previous papers he has shown that clay, if baked in a magnetic field, becomes permanently magnetised in such a way that its magnetic axis coincides with the direction of the magnetic field. Hence by measuring the direction of the permanent magnetism of clay articles, the date of manufacture of which is known, and on the assumption that they were placed in a certain position when baked, to deduce the value of the dip. With a view of testing the value of this method, a series of preliminary experiments have been made, by baking a number of cylinders and cones of clay in a furnace which was quite free from iron, the test-pieces being placed in positions the relation of which to the direction of the earth's magnetism were carefully noted. After cooling the baked clay test-pieces were placed, with their axes east and west, at a certain distance from a magnetometer, and from the magnitude of the deflections produced when the objects are rotated into different positions, the direction of the permanent magnetism is deduced. The author reserves an account of the results for a future paper.

ATTENTION has lately been directed to the surgical uses of oxygen gas, the treatment consisting essentially in the exposure of affected parts to the action of the gas, either pure or diluted with purified air. An account of some remarkable results obtained by this means is given in a recent number of the *British Medical Journal*, by Mr. George Stoker. Examinations of the bacteriological conditions of affected parts before and after treatment, show that oxygen has a selective action in reference to micro-organisms in the wounds, destroying some and encouraging the growth of others. In all healthy and rapidly healing wounds certain micro-organisms regarded as favourable to recovery are found, while others are regarded as unfavourable micro-organisms. Whatever may be the connection between the organisms and the state of a wound or sore, it seems to be established that when, in a wound treated by oxygen, healing is arrested or retarded, there is always a corresponding decrease of favourable and increase of unfavourable micro-organisms. If the strength of the oxygen bath be increased when this condition arises, the character of the micro-organisms from the wound is entirely reversed. Oxygen thus encourages the growth of micro-organisms characteristic of healing wounds, with the result that a cure is rapidly effected. A long and varied experience of the oxygen treatment has led Mr. Stoker to conclude that the method heals in less time than any other form of treatment, allays pain, stops foul discharges, forms a healthy new skin, and is far more economical and less expensive than any other form of treatment, both as regards suffering and money.

To the *Revue Générale des Sciences*, of October 15, Dr. Bernard Renault contributes an interesting article entitled "Les Bactéries et leur œuvre Géologique," in which he comes to the following conclusions: (1) That the bones, shells, and teeth of animals in Primary times were infested and destroyed by bacteria, analogous in their form and size to those which, at the present day, produce caries. (2) That formerly the remains of plants were invaded by multitudes of bacteria, some attacking the membranous cellular tissue, and others the thicker portions. Some of the bacteria acted more particularly upon the spores contained in the sporangia of ferns; the parenchymatous tissue first disappearing, then the woody fibres, and finally the cells of the epidermis. (3) That if nothing occurred to arrest the progress of bacteria, every part of plants would disappear successively, and only numerous colonies or zoogloea formed by micro-organisms would remain visible. (4) That these zoogloea often served as centres of attraction for mineral matters, amorphous or crystalline, thus producing oolitic or spherulitic structures in rocks. (5) That coal contains considerable quantities of bacteria, which, by causing the formation of hydrogen and carbonic acid, have brought cellulose and its derivatives to the chemical composition of this combustible." (Even during the preparation of his article, Dr. Renault found micrococci and bacilli in coal from Saint Étienne, Commentry and Vicoigne, in Tertiary coal, and in the coal of Transylvania.) Dr. Renault suggests that the work of bacteria, which goes on in marshes, ponds, &c., was stopped by the rising of water, frequent in Primary times, and capable of carrying away plants, having undergone a more or less complete transformation in lakes of a certain extent, into seas where fermentation became impossible owing to their depth. The physical properties of coal—density, hardness, tenacity, &c.—have, therefore, he concludes, only appeared as the result of a slow compression at the centre of a permeable medium, the compression being due to the various layers which covered the coal.

PROF. H. B. DIXON and H. Brereton Baker have investigated the influence of Röntgen rays on some chemical actions, but from their note, published in the *Transactions* of the Chemical Society, it appears that the results have hitherto been negative. The effect was tried on mixtures of carbon monoxide and oxygen (dried and moist), hydrogen and oxygen, carbon monoxide and chlorine, hydrogen and chlorine, and, lastly, hydrogen sulphide and sulphur dioxide (dried). No combination, either explosive or gradual, occurred between the gases exposed. The combination of chlorine with carbon monoxide and with hydrogen is effected by light, but the addition of Röntgen rays did not alter the rate of combination. Although the rays cause electric discharge from metallic bodies, they appear to have no effect on electrolysis. The action on a photographic plate is probably caused either directly or by the fluorescence of the film. It is not due to fluorescence of the glass, because the deposit of silver takes place entirely on the side of the film exposed to the rays.

THE Royal Meteorological Institute of the Netherlands has recently published a volume containing interesting *Mededeelingen*, or extracts from the log-books of Dutch ships navigating various parts of the world. The extracts include noteworthy phenomena relating to atmospheric electricity, unusual disturbance of the compass needle, volcanic eruptions and earthquakes, icebergs, &c. The first edition of this work appeared in 1867; in the twenty-nine years which have elapsed, a large amount of material has accrued, which made it desirable to recast the whole work, rather than issue a supplementary volume. It may be worth noting that the present work also contains a discussion of meteorological observations made on the Congo, and particulars relating to a few places on the coast of Lower Guinea.

IN the *Indian Meteorological Memoirs*, vol. vi. part iii., 1896, Mr. J. Eliot publishes an important discussion of the hot winds of Northern India. The chief features of the air movement in the hot weather months of March, April, and May are: (1) A feeble motion during night time, increasing rapidly to about 2h. p.m., and, under favourable conditions, blowing almost with the force of a gale during the next two or three hours; (2) intense dryness and excessive temperature, in which the humidity occasionally falls as low as two or three per cent., and the shade thermometer ranges between 105° and 115°; (3) clouds of dust, which give a peculiar reddish glare to the sunlight. Mr. Eliot shows, from careful comparisons of hourly observations of the various elements, that the more important features of the hot winds are practically identical with the winds of the cold weather months, the difference of their characteristics being chiefly due to the altered climatic conditions of the period.

THE United States Naval Observatory stands in a reservation of seventy acres. The magnetic buildings are on a small knoll surrounded by a deep ravine, and the only disturbances to which the magnetic observations are subject arise from an electric railroad, trolley system, at a distance of 1375 feet from the instruments. The ravine appears to diminish the effect of the railroad, for neither the declination nor the horizontal force instrument shows evidence of disturbance, though the vertical force records are slightly affected. Appendix I. to Washington Observations, 1894, is devoted to the magnetic work at the Observatory during that year by Lieut. C. C. Marsh. All the records are tabulated in periods of 26·68 days, instead of the calendar months, the calendar followed being that drawn up by Prof. Frank Bigelow. This plan has been adopted with the view of further studying the relation between the sun and the earth's magnetism. Several plates accompany Lieut. Marsh's report; and among the subjects illustrated by them are the Observatory grounds and buildings, composite curves of declination and horizontal force, curves of diurnal variations of the magnetic elements, and curves of hourly and monthly disturbances of the declination.

THE atomic weight of magnesium has recently been redetermined with great care by Prof. Richards and Mr. Parker, of Harvard, and an account of their results appears in the current numbers of the *Proceedings of the American Academy of Sciences* and the *Zeitschrift für anorganische Chemie*. The previous determinations of the atomic weight of this element showed a remarkable inconsistency until the year 1884, when Marignac recorded the results of a large number of closely concordant experiments pointing to the number 24·37. The accuracy of this number has now been confirmed by Messrs. Richards and Parker. The method selected was the analysis of magnesium chloride. The salt was prepared, with great precautions, from the double magnesium and ammonium chloride by heating in a current of dry hydrogen chloride; it was then transferred to a weighing tube, without the possibility of contact with moisture, and the chlorine precipitated by silver nitrate, either gravimetrically or volumetrically. The results of four series of very concordant experiments give the number 24·362 as the atomic weight of magnesium when oxygen is taken as 16·00, or 24·179 if oxygen be taken as 15·88.

In the *Zeitschrift für Elektro-chemie* for October 5, Messrs. E. J. Constam and A. von Hansen describe the preparation of potassium percarbonate by the electrolysis of a solution of potassium carbonate. It may be assumed that the alkali carbonates, like the salts of other dibasic acids, dissociate in very concentrated solutions more or less completely into the ions $\overset{+}{M}$ and $M\overset{-}{HCO_3}$, the latter may, under favourable circumstances, combine, at the moment of their separation at the anode, to form a percarbonate. In order to test this view, the authors have electrolysed a strong solution of potassium carbonate. At ordinary temperatures oxygen is evolved at the anode, and potassium bicarbonate precipitated; as the temperature falls the evolution of oxygen slackens, and at −10° ceases almost entirely, a bluish amorphous powder appearing in place of the potassium bicarbonate. The best results are obtained with a saturated solution of potassium carbonate at temperatures not higher than −15°. The current density (from 1 to 300 ampères per square decimetre) appeared to have little effect on the yield. The bluish precipitate is rapidly decomposed by water at the ordinary temperature, and must, therefore, be rapidly filtered off, dried on porous porcelain, and finally over phosphorus pentoxide. It then forms a bluish white, amorphous, hygroscopic powder. It loses carbon dioxide and oxygen when heated; in ice cold water it dissolves without decomposition, but the solution evolves oxygen at the ordinary temperature. It liberates iodine from potassium iodide or hydriodic acid, oxidises lead sulphide to sulphate, decolourises indigo, reduces manganese and lead peroxides, and evolves oxygen when treated with silver oxide. Dilute solutions of caustic potash or of sulphuric acid decompose it with formation of hydrogen dioxide.

THE additions to the Zoological Society's Gardens during the past week include two Chacma Baboons (*Cynocephalus porcarius*, ♂ ♀) from South Africa, presented by Captain Baker; a Grand Galago (*Galago crassicaudata*)) from East Africa, presented by Mrs. Le Poer Richardson; a One-streaked Hawk (*Melierax monogrammicus*) from West Africa, presented by Mrs. Palmer; an Oyster-catcher (*Hæmatopus ostralegus*), European, presented by Miss Beatrix Martin; two Ortalan Buntings (*Emberiza hortulana*), British, presented by Mr. John Young; a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, two Choughs (*Pyrrhocorax graculus*), British, deposited; two Black Swans (*Cygnus atratus*) from Australia, two Coscoroba Swans (*Cygnus coscoroba*) from Antarctic America, purchased.

OUR ASTRONOMICAL COLUMN.

MARS.—A Kiel telegram, dated November 11, gives us the following information. "Mars, Trivium Charontis double November 10. Flammarion."

Trivium Charontis is not a canal, but one of those "oases," as Lowell terms them. It forms the meeting point of no less than nine canals, namely: Orcus, Erebus, the twin Hades, Styx, Cambyses, Cerberus, Laestrygon and Tartarus. The observation above referred to is of importance in that Lowell seems never, as far as we know, seen them double. He defines them as being regular both in position and shape. When they form the point of intersection of single canals they appear as round spots, but in the case of double canals "they look like rectangles with the corners rounded off." The most striking case he noticed was the very oasis, Trivium Charontis, that is in question. Lowell found also that the oases "grew" as the canals appeared to grow, so that this observation of Flammarion may be of a special interest as regards the development of this, the largest Martian oasis.

EPHEMERIS FOR COMET PERRINE.—A postal card from Kiel, dated November 7, informs us of the elements and ephemeris of this comet for the ensuing week, computed by Prof. H. Kreutz from observations made on November 2, 4, and 6. These are as follows:—

T = 1897 February 6·819 Berlin Mean Time.

$$\left.\begin{aligned}\omega &= 164\ 58{\cdot}8\\ \Omega &= 85\ 10{\cdot}2\\ i &= 146\ \ 5{\cdot}4\end{aligned}\right\}\ 1896{\cdot}0.$$
$$\log q = 0{\cdot}06722$$

Ephemeris for Berlin Midnight.

1896.	R.A. h. m.	Decl. ° ′	Log Δ.	Br.
Nov. 10 ...	20 9·6 ...	+19 3 ...	0·206 ...	1·0
14 ...	20 5·0 ...	16 12 ...	·219 ...	1·0
18 ...	20 1·3 ...	13 34 ...	·233 ...	1·0
22 ...	19 58·2 ...	11 9 ...	·246 ...	0·9
26 ...	19 55·9 ...	8 55 ...	·259 ...	0·9

Prof. Holden has also communicated elements calculated from observations made on November 2, 3, and 4. These are somewhat different from those given above, but the computed position for November 18 is not far from that given in the above ephemeris, being R.A. 20h. 1·8s., Decl. 13° 57′.

On the 10th the comet was nearly in a straight line, joining δ and γ Sagittæ, being about as far from γ as δ is, only on the opposite side. The motion in declination is in the direction of α Aquilæ, near which star the comet will be found on the 26th.

THE LEONIDS.—In a preceding number of NATURE (vol. liv. p. 623), Mr. Denning gave full information for those wishing to observe this star shower with the naked eye, but, curiously enough, he did not mention the great advantage photography would afford us in obtaining a very accurate determination of the radiant point. One can quite understand that, by placing a small camera on a telescope equatorially mounted, and employing a wide angle lens oriented towards the radiant point, a large space in the sky can be included on the plate sufficient to catch many of the streaks if they be at all numerous. The plates can be changed every thirty minutes or so. It was the intention of the writer of this note, some fourteen days ago, to adopt this principle, and he has already been able to get the necessary apparatus ready. The use of a wide angle lens necessitates that, if an equatorial be used, the camera must be placed at the extreme end (object-glass end) of the telescope, otherwise the opening in the shutters will cut off some of the field, and in consequence neutralise to some extent the value of the wide angle. This was found to be so; but, by the kindness of Mr. J. Norman Lockyer, a siderostat was placed at his disposal. The instrument not having yet been set up since its return from the eclipse expedition, it was erected temporarily in a good position open towards the eastward.

Captain Abney has very generously lent a Cooke's lens, invented by Mr. Dennis Taylor, giving a field of about 75° and of about five inches focal length, so that only now fine weather is required.

It may be mentioned that the current (November) number of *The Observatory* contains an interesting article by Dr. Johnstone Stoney on the "Leonids," in which he quotes an extract from a letter received from General Tennant, who advises practically the same method described above. The appendix to this article contains a reference to the literature on the subject of the Leonids, from which we make the following summary.

Prof. H. A. Newton, *Silliman's Journal*, 1864, vols. xxxvii. and xxxviii. pp. 377 and 53 respectively. Prof. Adams, *Comptes rendus*, March 25, 1867, p. 651, and *Monthly Notices R.A.S.*, April 1867, p. 247. Signor Schiaparelli, *Les Mondes*, December 1866, and beginning of 1867. English outline of Schiaparelli's work, by Prof. Newton, *Philosophical Magazine* for July 1867, p. 34. M. Le Verrier, *Comptes rendus*, January 21, 1867, p. 94. Dr. Johnstone Stoney, *Monthly Notices R.A.S.*, June 1867, p. 271, and *Philosophical Magazine*, September 1867, p. 188.

SUNSPOTS, COMETS, AND CLIMATE VARIATIONS.—A problem of considerable interest is suggested by the paper which Herrn Johannes Unterweger contributes to vol. lxiv. of the *Denkschriften der Math. Natur. Wissen. Classe der Kais. Akad. der Wiss.* of Vienna. The pamphlet, which has been printed separately, is entitled, "Ueber zwei Trigonometrische Reihen für Sonnenflecken, Kometen und Klimatschwankungen," and contains a preliminary statement of the investigation in question. The main result of the work is that there seems to be found a striking similarity between the variations of a certain function obtained from periodic comets near perihelion and the curves illustrating sunspot and climate variations. This function is obtained from a formula (see *Denkschriften Kais. Akad. Wien.*, vol. lix.) that he has previously published, which gives a relationship between the function and the inclinations and perihelion distances of well-observed periodic comets. The comets dealt with are divided into two groups, according as their perihelia lie to the north or south of the solar equator, and the mean of those which pass through their perihelia during each year is taken. The author then finds two trigonometrical series which represent the periods of both sunspot frequency and the variations of this cometary function, the former of which includes a secular variation of about 70 years, while the latter indicates a 35-year variation corresponding with that due to climate variations. In the curves shown, Herrn Unterweger indicates a variation in the minima as well as in the maxima in the case of the calculated frequency of sunspots, the former of which does not really occur as observation shows. The investigation is, however, full of interest, and perhaps the more detailed discussion which he promises will throw more light on this question.

THE EXPLOSIVE PROPERTIES OF ACETYLENE.

IN view of attempts to extend the use of acetylene as an illuminant, the disastrous explosion in Paris, to which reference was made in our issue of October 22, has created a good deal of anxiety in this country. In this connection it may interest our readers to have a further account of the memoir on the explosive properties of acetylene recently presented to the French Academy by MM. Berthelot and Vieille (see NATURE, vol. liv. p. 591).

The authors state that in acetylene at ordinary pressures neither an electric spark, nor a flame, nor an explosion of fulminate will cause more than a local dissociation of the gas (a fact already established by Prof. H. B. Dixon), but that if the gas be compressed beyond two atmospheres, the dissociation, once started, is propagated without sensible diminution throughout the whole mass of gas. In this way dissociation of the gas was effected in a tube 20 millimetres in diameter and 4 metres long. The acetylene splits up into pure hydrogen and a friable mass of carbon, which forms a cast of the containing vessel, and can be withdrawn intact. At a pressure of 20 atmospheres, which is about half the tension of the saturated vapour of liquid acetylene at 20° C., the explosion develops a tenfold pressure, but the rate of propagation is much below that of true explosive wave of such a mixture as electrolytic gas. The temperature due to the explosion at this pressure is calculated to be 2750° C. As the violence of the explosion increases with increasing initial compression, it was to be expected that liquid acetylene would exhibit the character of a "high" explosive. This MM. Berthelot and Vieille have shown to be the case. Eighteen grammes of liquid acetylene exploded in a steel bomb of 49 c.c. capacity by a hot wire developed a pressure of 5564 kilogrammes per square centimetre. This corresponds to an explosion pressure for the liquid alone of about 9500 atmospheres—a value approaching that of guncotton. The decomposition of liquid acetylene by simple ignition is relatively slow, and appears to take place in two stages, one corresponding to the decomposition of the gas, the other that of the liquid. In an experiment where the liquid occupied ·15 of the containing vessel, a maximum pressure of 1500 kilogrammes per square centimetre was recorded.

Experiments were made to determine whether the compressed gas or liquid could be exploded by mechanical shock. The results were, strictly speaking, negative. Neither by fall, nor crushing with a ram, nor by the impact of a bullet which pierced the containing cylinder, was the acetylene exploded. In the case of liquid acetylene, an explosion followed the shock after a short interval, but this was shown to be due to the ignition of the escaping gas, after admixture with air, by a spark from the breaking metal. A small charge of fulminate of mercury fired in the middle of a cylinder of liquid acetylene detonated the liquid, and shattered the cylinder in the manner of a true explosive.

The authors describe the conditions under which danger may arise by casual elevation of temperature during the manipulation of acetylene. In the first place they note that in generating acetylene by the action of a small quantity of water or excess of calcium carbide in a closed vessel, the carbide may become incandescent and lead to the detonation of the gas. At least one accident due to this cause has already been recorded. Sudden compression of the gas in filling cylinders, or in admitting it into a reducing valve, may likewise raise the temperature to the point of danger. A sharp mechanical shock breaking the containing vessel may cause sparks capable of firing the explosive mixture formed by the escaping gas with the external air.

In conclusion MM. Berthelot and Vieille express their opinion that the dangers of acetylene are not such as to outweigh its advantages as an illuminant. They add that by simple precautions, such as the slow transference of the compressed gas from vessel to vessel, and the careful cooling of the vessels in which the gas is being compressed, the dangers which they have explained may be easily avoided.

The comfort afforded by these concluding remarks is somewhat abated by the fact that the explosion at M. Pictet's factory was subsequent to the publication of MM. Berthelot and Vieille's memoir. There is no occasion for panic, but the matter evidently demands the most careful attention from the authorities in this as well as in other countries. A. SMITHELLS.

THE PRINCETON SESQUICENTENNIAL.

THE celebration of the one hundred and fiftieth anniversary of the founding of Princeton University, held October 20-22, was doubtless, in some respects, the most brilliant and impressive academic event in all American history. Certainly no other celebration can be compared with it than the Harvard Quarter Millennial of 1888. Most of the leading universities, and many of the smaller universities of America, sent their president; Harvard, Cornell, Columbia, Chicago, Johns Hopkins, Pennsylvania, and Toronto were thus represented. Of the great universities in the United States, Yale alone sent a delegate other than the President, who is now abroad.

The visiting delegates from Europe delivered a series of lectures the week before the anniversary exercises. Prof. Edward Dowden, of Dublin, gave six lectures on "The French Revolution and English Literature"; Prof. Felix Klein, of Göttingen, gave four lectures on "The Mathematical Theory of the Top"; Prof. J. J. Thomson, of Cambridge, four on "The Discharge of Electricity in Gases"; Prof. Andrew Seth, of Edinburgh, gave two on "Theism"; and single lectures were delivered by Prof. Carl Brugmann, of Leipzig, on "The Nature and Origin of the Noun Genders in the Indogermanic Languages"; and Prof. A. A. W. Hubrecht, of Utrecht, on "The Descent of the Primates." Among other foreign delegates were Prof. Henri Moissan, of Paris, Demetrius Botassi, of Athens, and Goldwin Smith, late of Oxford.

Among the proceedings was the unveiling of a table in Nassau Hall, commemorative of the change of name of the University from that of the "College of New Jersey," which has always been its official designation, to "Princeton University," which has already long been its popular designation.

Gifts, amounting to 1,350,000 dollars, have been contributed in honour of the Sesquicentennial, and to mark the change in the Institution's title.

The honorary degree of LL.D. was conferred upon the following delegates, among others:—Wilhelm Dörpfeld, First Secretary of the German Archæological Institute, Athens, Greece; A. A. W. Hubrecht, Professor of Zoology in the University of Utrecht; Felix Klein, Professor of Mathematics in the University of Göttingen; Henri Moissan, Professor of Chemistry in the University of Paris, and Member of the French Academy of Sciences; Edward Baynall Poulton, Hope Professor of Zoology in the University of Oxford; Joseph John Thomson, Cavendish Professor of Physics in the University of Cambridge; J. Willard Gibbs, Professor of Mathematical Physics in Yale University, New Haven, Ct.; Daniel Coit Gilman, President of the Johns Hopkins University, Baltimore, Md.; George Lincoln Goodale, Fisher Professor of Natural History, and Director of the Botanical Garden in Harvard University, Cambridge, Mass.; George William Hill, Member of the National Academy of Sciences, Foreign Associate of the Royal Astronomical Society, West Nyack, N.Y.; William James, Professor of Psychology in Harvard University, Cambridge, Mass.; S. P. Langley, Secretary of the Smithsonian Institution, Washington, D.C.; Joseph LeConte, Professor of Geology and Natural History in the University of California, and President of the American Geological Society, Berkeley, California; John W. Mallet, Professor of Chemistry in the University of Virginia, Charlottesville, Virginia; Silas Weir Mitchell, Philadelphia, Pa.; Simon Newcomb, Nautical Almanac, Navy Department, Washington, D.C.; William Peterson, Principal of McGill University, and Professor of Classics, Montreal, Canada; Ira Remsen, Professor of Chemistry, and Director of the Chemical Laboratory in the Johns Hopkins University, Baltimore, Md.; Henry A. Rowland, Professor of Physics, and Director of the Physical Laboratory in the Johns Hopkins University. The degree was also conferred upon Lord Kelvin and Prof. Otto Struve *in absentia*.

One of the most pleasing and hopeful features of the Princeton celebration was the note of peace and good will to all mankind, which such international gatherings powerfully promote. The first sentiment which called out applause was the hope expressed by President Patton in his opening sermon, that the peace and harmony now happily existing between the two great English-speaking nations might henceforth nevermore be broken; and when in the afternoon of the same day Prof. Thomson, of Cambridge, at the reception of delegates, said that he was glad the revolutionary war had resulted in independence of the United States, as he considered that the best solution of the question, and that England, as well as America, now rejoiced in this outcome of the struggle, the applause was unstinted. WM. H. HALE.

THE OPENING CEREMONY OF THE GATTY MARINE LABORATORY, UNIVERSITY OF ST. ANDREWS.

THE formal opening of the Gatty Marine Laboratory, the general arrangement of which has been already described in NATURE, took place on Friday, October 30, by Lord Reay, a former Rector of the University, in the presence of the Principal and Professors, the representatives of various scientific societies, universities, and colleges, and a distinguished company. In his address Lord Reay paid a tribute to Dr. Gatty for his discriminating generosity. He observed that in countries such as France money was more readily forthcoming for science. He spoke in warm praise of the labours of the late Lord Dalhousie in the cause of the fisheries, and pointed out how important scientific knowledge was in regard to fisheries legislation. Moreover, that whatever revelations science has in store for us cannot be evaded. He was inclined to think that a few central institutions thoroughly well equipped, were better than many incomplete and inefficient schools. The work in the Gatty Marine Laboratory would be of a purely scientific character, but it would be of the utmost value to all who were interested in the prosperity of our fisheries. A glance at the papers published since the opening of the old Laboratory in 1884, showed how essential their contents were for those who wish to protect our fisheries, and who often attempt it in the wrong way. He drew attention to the unique position of the University in regard to the study of marine biology.

Prof. Sir William Flower then followed, and he traced the growth of the study of marine animals during the last fifty years. In former days the zoologist had to depend on the rock-pools, or specimens stranded by storms, or had to work on board ship. Especially he pointed out the development of aquaria from their simplest form to the present great tanks. He then adverted to the growth of zoological stations over the world, and considered that St. Andrews, by its work, had come to be a centre for the study of problems connected with the fisheries. Its laboratory was the first that was fairly established in the British Isles; and while he knew that Edinburgh was often called the Athens of the North, he would now say that St. Andrews had many claims to be called the Naples of the North.

The Dean of the Faculty of Arts then presented the following gentlemen for the degree of LL.D.:—Prof. Sir William Flower, K.C.B., F.R.S; Rev. Dr. Henry B. Tristram, F.R.S.; Prof. Michael Foster, Sec.R.S.; and Prof. Gustave Gilson, Louvain.

Dr. C. H. Gatty then expressed his gratification at the interest taken in the new Laboratory, and handed to Lord Reay a silver key wherewith to open the door.

Prof. McIntosh, on behalf of the University and the scientific workers, conveyed their thanks to Dr. Gatty for his munificent gift.

Thereafter the Laboratory was inspected by the company. In addition to the living animals in the tanks, the walls of the lobby were hung with coloured drawings of marine animals—enlarged to various degrees, and many beautifully and softly painted—all by the late Mrs. Gunther. These drawings consisted almost entirely of representations of living forms from St. Andrews

Bay, coloured from life. A few were also hung in each room. In the tank-room were various nets (surface, large mid-water and bottom), circular flounder-nets, mussel and other dredges, mussel and cockle implements, Italian eel-spear, hand-nets, scoops, water-telescope, thermometers (surface, deep-sea, and open-air), sieves, and various models of trawls, crab pots, &c. In the Director's room were the multitudes of preparations connected with the life-histories of the food fishes, rare pelagic forms, such as the larval *Polygordius*, *Mitraria*, *Tornariæ*, and the wonderful larva of *Luidia*. In the specimen-room were the type-series of the pelagic fauna of the Bay from January to December, an extensive collection of pelagic ova of fishes from various parts of the eastern and western shores of Scotland, a series of preparations connected with the life-history of the salmon, a reference-collection of invertebrates, including an interesting series of the mussels of the Eden, oysters from the Forth and from Whitstable, a series of fishes, and other preparations.

THE INSTITUTION OF MECHANICAL ENGINEERS.

On the evenings of Wednesday and Thursday of last week, the 4th and 5th inst., an ordinary general meeting of the Institution of Mechanical Engineers was held in London, the theatre of the Institution of Civil Engineers having been lent for the purpose. The President, Mr. E. Windsor Richards, occupied the chair on both evenings.

There were three papers set down for reading, as follows:—

"Research Committee on the Value of the Steam-Jacket; Experiment on a Locomotive Engine," by Prof. T. Hudson Beare and Mr. Bryan Donkin.

"Transmission of Heat from Surface Condensation through Metal Cylinders," by Lieut.-Colonel English and Mr. Bryan Donkin.

"Breakdowns of Stationary Steam-Engines," by Mr. Michael Longridge, of Manchester.

The two first papers were taken on Wednesday, Thursday evening being devoted to Mr. Longridge's memoir.

The Research Committee on the Value of the Steam-Jacket has been in existence for a long time now, and has proved one of the least, if not actually the least satisfactory of all the research committees constituted by the Council of the Institution. Most of these committees have done admirable work, and added largely to the stock of professional knowledge and accumulated data which engineers have to draw. Steam-jacketing is perhaps the most abstruse question which has been made the subject of an inquiry, comprising, as it does, problems extending beyond engineering proper far into the province of physical science. Nevertheless, in the present day of enlightenment, with the professor so widely abroad, more ought to have been done than has been done by this committee. It would be difficult to select an engine more unfitted for making an inquiry upon as to the value of the steam-jacket than an ordinary locomotive. Its rapid piston speed—or, rather, the high rate of turning—alone is sufficient to render it unsuitable for this inquiry; but, in any case, a locomotive is the most difficult engine from which to obtain experimental data. It is an athletic feat of no mean order to take even indicator diagrams, when one has to hang on to the side of an engine travelling at a speed varying from anything up to sixty, or perhaps eighty miles an hour. Then a locomotive, even with constant train load—a condition which can hardly be ensured in ordinary work—is seldom for five minutes at a time exerting the same power, owing to varying gradient, state of the rails, and force or direction of wind—the latter a most important consideration. Steam may be shut completely off when descending a steep bank, or the regulator may be full open and link in the last notch under exactly opposite conditions. Between these two states we have all grades of linking-up, an operation which so affects the distribution of steam—compression, expansion, &c.—that one would think the steam-jacket would finally give its job up in disgust from fair despair of knowing what it should do.

The result of all this is shown in the report, which possesses the merit of being absolutely honest and straightforward. Four trial runs were made between Manchester and York during ordinary working, with its attendant stoppages and delays. The steam-jacket fitted was of a temporary nature, and the method of testing was to make one run each way with the jackets in steam, and a like number of runs with the jackets empty. Coal was weighed and feed-water measured by a Siemens' meter. Mr. Michael Longridge drew off samples of chimney gases for analysis. Jacket-water was also drawn off and measured. Speed was taken by a Boyer recorder, and the revolutions assumed from its records.

In spite of the fact that we know nothing more about the value of the steam-jacket than we did before the experiments were made, the trials added, as a by-product, something to the knowledge of railway engineers on the performance of the locomotive; but, in any case, the thanks of the Institution are due to the authors of the paper for their disinterested labours.

The second paper was a complement to the first; for the rate of transmission of heat to and through metal is the chief thing necessary to be known for determining the value of steam-jacketing of engine cylinders. The problem is a vexed one, and no inquiry yet made has taken us beyond its threshold. The authors have attacked the subject by an endeavour to ascertain the actual temperature in the interior of the metal, and by observing the exact appearance of the film of water deposited, and, further, by determining whether such a phenomenon as cloudy steam really exists. Their apparatus consisted of a strong vertical glass cylinder about 5⅜ inches in diameter and 2⅞ inches high. Inside this was placed a metallic cylinder. The annular space between the glass cylinder and the enclosed metallic cylinder was filled with steam, whilst through the interior of the metal cylinder an ascending stream of cooling water was made to circulate. In order to determine the thermal gradients in the metal, when its thickness allowed of so doing, the temperatures of the interior were taken in vertical holes 1/8 or 1/16 of an inch in diameter, drilled at different distances from the condensing surfaces, and filled with mercury, into which slender thermometers were inserted. Illustrations of the apparatus were hung on the walls of the theatre, and will be reproduced in the published volume of the *Transactions* of the Institution. The pressure of steam, volume and temperature, of circulating water, and other trial conditions were controlled by suitable apparatus. The first result arrived at was that the authors consider it was not possible to trace the slightest appearance of cloudiness or mist, or of water suspended in the body of the condensing steam. The water of condensation was deposited on the surfaces. A reproduction was given of a photograph of the film of water on the surface of smooth cast-iron as it appeared through the glass cylinder, the steam pressure being 20 lbs. per square inch, and the rate of condensation somewhat slow.

The velocity of circulating water varied between 0·032 and 0·415 feet per second. The different metallic cylinders tried were made from cast-iron with both rough and smooth surfaces 11/32 and 31/32 of an inch thick, copper, and brass with smooth surfaces 2/32 of an inch thick, and smooth steel 1/32 and 10/32 of an inch thick. The rate of heat transmission was found by observing the rise of temperature in a known quantity of circulating water, and by noting the weight of steam condensed. Corrections were made to allow of accidental losses. Without publishing the diagrams on which the results of the experiments were plotted, it would be impossible to give details of the observed results unless we printed the voluminous tables attached to the papers. The greatest quantity of heat transmitted per second was about thirty-five thermal units, and the least seven thermal units per square foot of internal surface of cylinder. The authors consider that the film of water deposited by condensation, and adherent to a metallic surface, resists the transmission of heat in exactly the same way as an equivalent greater thickness of metal would do. The thickness of the water films, as determined by the difference of temperature, is less on a smooth surface of cast-iron than on a rough one, and is apparently not affected by the admission of steam-jets to sweep the surfaces. There is, the paper says, no apparent difference in the resistance to transmission of heat between the surface-layer of metal and the next to it; or, in other words, there is no drop in temperature on entering or leaving the metal. The thermal gradient at any point in the metal would be uniform in a flat plate, and becomes steeper towards the interior of a hollow cylinder as the circumference diminishes. At any point on the surface of the metal next to the circulating water, the temperature, owing to an adherent film in which the thermal gradient exists, is much in excess of the mean temperature of the circulating water at the same point.

In the discussion which followed the reading of this paper, Mr. Longridge said that the observed result of the steam being not cloudy, all the moisture being concentrated in a film on the walls of the cylinder, would materially affect the conditions involved in passing steam from a jacket to a cylinder, as the steam would not carry condensed water with it. Mr. Halpin questioned the fact of there being no additional resistance to the transmission of heat owing to multiplication of surfaces. The authors' statements on this point are opposed to the opinions held by many engineers; and even if they are right in regard to areas absolutely in metallic contact—like floating surface plates—those perfect conditions are not present in practical engineering work.

The second evening of the meeting was devoted entirely to Mr. Longridge's paper; a most useful contribution to the *Transactions* of the Institution, although not very easy to follow without the aid of illustrations. The paper dealt with 1000 break-downs of factory engines which had come before the author's notice. These Mr. Longridge had analysed and classified in order to show which parts of the engines gave way first, and as far as possible the causes of failure were stated. In some instances the author suggested steps which should be taken to avoid similar mischances in the future. The thousand break-downs were divided into 23 groups, and these were again sub-divided into divisions. Thus there were 213 accidents due to the giving way of "valves and valve gear," and in these were included the giving way of 46 valve spindles, 24 eccentric straps, 23 rocking shafts and levers, 21 nuts, cotters, and pins, 18 eccentric rods, 17 slide valves, besides other parts of valve gear in lesser proportions. It is notable, considering how much dread some millowners have of the "clattering Corliss gear," that only seven accidents are chronicled against this method of steam distribution, especially when one remembers how largely it is now used in Mr. Longridge's district of Lancashire. Valve spindles break when screwed, and this fact leads the author very properly to exclaim against the use of V-threads. Gas threads, he says, are better; and round threads best of all. The sharp V-thread is like the commencement of a tear. Next to valve gear "spur wheels" come on the list, with a total of 124 accidents. Mr. Longridge only includes wheels on the crank shaft; if he had taken second-motion shafts, the total would have been incomparably greater. Back-lash is the most fruitful source of mishap with toothed wheels, and a most fruitful source of back-lash is placing spur gearing and rope or belt pulleys on the same shaft, when the second motion shaft is apt to overrun the main shaft. Uniform load, a heavy fly-wheel, and slow speed of ropes, are points that need to be observed in such cases. Vibration is also a frequent cause of accident with spur gearing. Machine-moulded teeth are best, and it is desirable to carry the toothed quadrants on the arms of the fly-wheel rather than have teeth on its periphery. Air-pump motions are next; they caused 121 breakdowns. The chief heading in this division is "weakness, wear and tear, or neglect"; causes which speak for themselves.

Air-pump buckets and valves were responsible for eighty-eight out of the thousand accidents. These mishaps were mostly due to the giving way of parts, foot-valves being the chief delinquents. In reference to accidents through broken packing rings in buckets, the author said he would as soon have plain buckets, packing rings being "expensive, dangerous, and entirely useless." One speaker, Mr. Saxon, who himself has had considerable experience with mill engines in the same district, agreed with the author in regard to low lifts, but if a high lift were required, he considered packing necessary. "Columns, entablatures, bedplates, and pedestals" accounted for eighty-six break-downs. The settlement of foundations is the most frequent cause in this division, and the author warns engineers against setting-up holding-down bolts in columns when the masonry settles, as this naturally brings undue stresses upon the structure of the engine. The difficulty is that engineers very often do not recognise that the masonry foundations are settling when a column becomes loose on its seating. The chief cause of the decay of foundations appears to be the deterioration of stones, and cement or mortar by oil getting to them. One speaker during the discussion—Mr. Rounthwaite, a marine engineer—asked why the designers of mill engines were so fond of brick-work, and suggested that it would be preferable if very deep cast-iron bedplates were used so as to reduce the masonry required. The author said that the gradual spread of the vertical or inverted type of engine facilitated the use of deeper metal bedplates. The horizontal engine had held its position so firmly because it gave a long stroke, but with the speeding up of mill machinery, characteristic of modern practice, a higher rate of revolutions was required, and this made shorter stroke engines preferable, so that the vertical type was gaining ground. Main shafts were the cause of forty-nine accidents, some of them the most interesting of the series. By far the greater number of shafts that broke down gave way through wear and tear. One veteran made 176 million revolutions before being taken out, owing to a mysterious grooving under an eccentric sheave. A Whitworth fluid-compressed steel shaft gave poor results, running only $61\frac{1}{2}$ revolutions, and giving way under the low stress of 4600 lbs. per square inch. This single case, however, will not be sufficient to destroy the high reputation of Whitworth shafts. Connecting rods, of which forty-one gave way, break almost invariably in the connections, gibs cotters, open-ended straps or bolts giving way; one instance of a body failure, through an imperfect weld, alone being recorded, although there were six failures of forked ends. Cylinders and valve chests, with which there were thirty-five accidents, mostly break on flat surfaces, covers, or doors; the presence of water being the chief cause. Parallel motions account for thirty-five breakages, mostly in eye shafts. Governors supplied twenty-eight accidents to the list, and piston-rods twenty-seven; cotter-holes being again the weak point. The author very rightly warns designers against abrupt changes of section in piston-rods, for though the average draughtsman appears to be quite alive to this evil in regard to castings, yet he often appears to think it produces no bad effect where the effects of unequal cooling are not to be anticipated. Piston-rod crop-heads afford twenty-seven examples of break-downs, mostly from "wear and tear"; the giving way of pistons supplies an equal number of mishaps, whilst the breaking of links contributes twenty-one accidents towards the total.

Nineteen break-downs of fly-wheels are recorded, the chief cause being internal stress—due presumably to ill-proportioned castings—whilst eight bosses were cracked, five by driving keys too hard. The author made some pertinent remarks on the question of keying fly-wheels on to shafts, describing the Lancashire method of "staking," which is the best plan for giving a true running and rigidly secured wheel without straining the boss. Mr. Holroyd Smith, in the discussion, sketched an improved form of key which appeared to be designed on sound principles. Air-pumps and condensers gave way thirteen times, gudgeons in beams twelve times, and cranks twelve times. Of the latter eleven were of cast-iron, so there is not much need to comment upon them. Eleven crank-pins broke; in one case a Whitworth steel pin gave way through the skin being injured by shrinking in the crank web. The tear being started, failure was but the result of time. There were only six instances of broken engine beams. One the author attributes simply to fatigue. The engine was made in 1847 and worked until 1892, when some fine cracks were noticed near the middle of the beam, which was of cast-iron. These cracks developed, extended, and joined up, so that the beam was condemned. Prof. Hudson Beare joined issue with the author on the propriety of attributing the failure of this beam to fatigue. He said that once the original crack was set up, the beam was in a less advantageous position to bear the load put upon it, so that the crack would be further developed until it finally succumbed.

The remaining causes of accident were failures of slide-bars five, and of ropes three; whilst an "entire smash," no cause ascertained, completes the roll of a thousand break-downs.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following science teachers in the University were, on November 7, elected members of the Council of the Senate: Alex Hill, M.D., Master of Downing, and University Lecturer in Advanced Anatomy; R. T. Glazebrook, F.R.S., Assistant Director of the Cavendish Laboratory; and A. E. Shipley, University Lecturer in the Morphology of Vertebrates, and Secretary of the Museums Syndicate. Dr. R. C. Jebb, M.P., and Dr. J. N. Keynes, Secretary of the Local Examinations Syndicate, were also among the successful candidates.

The Professorship of Surgery has been again suspended until the first day of next term, to give time for the further consideration of the stipend and conditions of tenure. It appears probable that an effort will be made to obtain at once the full stipend of £500.

Dr. J. T. Bottomley, F.R.S., has been appointed an Examiner in Physics, and Mr. L. Fletcher, F.R.S., an Examiner in Mineralogy, for the Natural Sciences Tripos.

At St. John's College, the following awards in natural science, for candidates not yet in residence, were made on November 9: O. May, Tollington Park College, and G. A. Ticehurst, Tonbridge School, Foundation Scholarships of £70 a year; L. Lewton-Brain, Firth College, Sheffield, Foundation Scholarship of £50 a year; L. Miall, Yorkshire College, Leeds, Minor Scholarship of £50 a year; A. J. Harding, Christ's College, Brecon, Johnson Exhibition.

Prof. A. C. Haddon, of the Royal College of Science, Dublin, has been approved for the degree of Doctor of Science.

We regret to announce the death, at Naples, on November 8, of Mr. J. E. Gray, of King's College, Harkness Scholar, who had just been appointed to occupy the University's table in the Zoological Station under Dr. Dohrn.

At St. John's College, the subjects included in the examinations for Entrance Scholarships and Exhibitions in Natural Sciences held in and after 1897 will be Chemistry, Physics, Zoology, Botany, Physiology and Physical Geography. Copies of the new scheme showing the scope of the examination in Chemistry, Physics, Botany and Physical Geography, and including specimen papers in Zoology and Physiology, may be obtained on application to any of the Tutors—Dr. Sandys, Dr. Donald MacAlister, or the Rev. C. E. Graves.

THE East Riding County Council have decided to devote £2000 of the grant received under the Local Taxation Act, 1890, to the relief of the rates. We looked for better things from Yorkshire. The action affords another argument in favour of a Bill for securing the whole of the "whisky money" to education.

DONATIONS amounting to about four million dollars have recently been conferred on, or promised to, the University of California; the largest gifts being from Mrs. Phebe Hearst, widow of the millionaire Senator. The money is to be paid after the State has expended half a million dollars in erecting new buildings. Mrs. Hearst has sent a note to the trustees, enclosing 15,000 dols. to be used in securing plans for the buildings. The architects of all nations will be invited to compete and to submit plans for a group of buildings of similar design, which will surpass anything of the kind in the world. Mrs. Hearst stated that she would erect two buildings at her own expense, one of which would be a memorial to her late husband.

WHEN it was decided to do something for technical education, six years ago, no worse blunder was ever committed than that of entrusting to newly-created Technical Education Committees the whole of the funds arising from the Customs and Excise dues, instead of allocating a definite proportion of the money to the already existing University Colleges, and for scientific investigation. The result of the neglect is that several of the University Colleges are continually in need of funds, and their development is checked on all sides by the ogre of expense, while Technical Education Committees in different parts of the country have a difficulty in spending the moneys under their control. The University College at Bristol is an example of an institution which has suffered, rather than profited by the Local Taxation Act of 1890. The Calendar shows that complete instruction for the London University degrees in science, art, and medicine, can be obtained at the college; and systematic instruction is given in those branches of applied science which are more nearly connected with the arts and manufactures. The results obtained, and the constitution of the professoriate, are sufficient evidence of the thoroughness of the instruction given; yet the college has practically no endowment—a paltry £75 a year, and that derived from a fund started by the students, and called "The Students' Endowment Fund." The other sources of income are: £1200 from the Government, £500 from the Bristol Town Council (for the maintenance of ten free students), £100 from the Company of Clothworkers, a few odd amounts, and the balance from students' fees. The income from annual subscriptions amounts to about £600. It is hardly necessary to say that the college cannot be kept going on such a small budget. Last year the accounts showed an adverse balance of £950, and a total indebtedness of more than £6000, part of which is due to a decrease of the Sustentation Fund, while the rest has been spent in building. An appeal for £10,000 was made in the early summer, and £8044 has been collected, £2000 of this being contributed by the Bristol Town Council, on condition that it should be used in the building of an engineering wing, which has now been completed, and was opened last week. There still remains £2000 to be collected if the college is to be kept out of debt; and we trust that some of the rich merchants in Bristol will subscribe this amount in recognition of the valuable work done, and of the high reputation the college has earned. If any of the great Livery Companies of London are looking for a worthy object to take under their fostering care, as the Drapers' Company have taken the University College at Cardiff, we commend to their attention the University College at Bristol. Two or three weeks ago the Home Secretary held out hopes that there would be an increase of the grant which the State now gives to University Colleges; and this assistance, when it arrives, should place the college at Bristol in a more satisfactory position, though it will not do everything. Never has it been more necessary than now that the various professions and industries should receive the benefits of special scientific education. To let institutions where sound secondary and university education can be obtained be perpetually struggling for existence is, therefore, to neglect one of the most, if not the most, important branch of our educational system.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. iii. No. 1.—The number opens with an account of the third summer meeting of the Society, which was held in the week after the meeting of the American Association for the Advancement of Science, in deference to the desire expressed by that body. The titles of the papers read, and abstracts of them follow. We give the ensuing abstract of Prof. J. McMahon's paper on the hypothesis of the successive transmission of gravity, and the possible perturbative effect on the earth's orbit. Suppose that the sun is moving in a straight line with velocity u, and that the whole system shares this translatory motion. Suppose, also, that the gravitational influence issues continually from the sun in waves that move outward with velocity v (perhaps equal to the velocity of light), and that when any wave reaches the earth the latter is attracted towards the wave-centre or point of space from which the wave issued. This effective centre of acceleration is at a distance from the sun, which varies between the limits $ka(1-e)$ and $ka(1+e)$ where k is the ratio of u to v, a is the semi-axis major and e the eccentricity of the earth's orbit. Then the orbit of the earth relatively to the sun is that which would be due to a centre of force that performs small oscillations about its mean position. The law of this oscillatory motion was determined, and the equations of acceleration of the earth in its orbit, along and perpendicular to the radius vector, were corrected for this small disturbance. Appropriate solutions of the resulting differential equations were given as far as terms in ke^2. The most important perturbative terms were examined, and their effect on the orbit determined.—"Celestial Mechanics" is a review, in Prof. E. W. Brown's exhaustive style, of astronomical papers prepared for the use of the American Ephemeris and Nautical Almanac (vols. v., vi., vii.; Washington, 1894-5).—Especial attention is directed to a result obtained in a memoir by Prof. Newcomb. "If the coefficients in the time in the arguments and of the periodic terms in Delaunay's results were all expressed in terms of L, G, H, a', e', the perturbations due to the indirect actions of the planets would be obtained by merely inserting the variable instead of the constant values of a', e'." Prof. Newcomb remarks that this curious theorem may embody some principle applicable to the disturbed motion of three bodies which has not yet been fully mastered. It seems probable, in Prof. Brown's opinion, from the way in which the result has been obtained, that it is a direct consequence of the use of canonical equations, and of the form in which the time appears in the result. The notes are very full, as also is the list of new publications.

Wiedemann's Annalen der Physik und Chemie, No. 10.—Measurement of low temperatures, by L. Holborn and W. Wien. Baths of pure liquid oxygen are very constant, and may be used for maintaining a temperature of $-182°$ C. Liquid air changes from $-189·1°$ to $-184·8°$ in half an hour, owing to the evaporation of the nitrogen. Oxygen with 7·6 per cent. nitrogen boils at $-183·2°$ under atmospheric pressure. Higher temperatures may be maintained by melting ethylbromide ($-129·5°$), ether ($-117·6°$), carbon bisulphide ($-112·8°$), methyl formate ($-107·5°$), toluol ($-102·0$), and ammonia ($-78·8°$).—Temperatures inside vacuum tubes, by R. W. Wood. These are measured by a platinum spiral acting as a bolometer. At an internal pressure of 0·3 mm. the rise of temperature ranged from 13° to 25·7° C. as the current varied from 0·0015 to 0·0036 amperes. At greater pressures the variation for the same current was higher. The author measured the temperatures of the bright and dark spaces by mounting the spiral on a glass arm penetrating into a Torricellian vacuum, and passing down through the mercury and up through the tank. This arm could be shifted up and down without interfering with the vacuum. In every case, the bright spaces were a few degrees hotter than the dark ones.—Electrostatic deflection of kathode rays, by G. Jaumann. When a quiet line of light is produced in a vacuum tube by a feeble current, it may be temporarily deflected by moving a rubbed glass or ebonite rod in its neighbourhood. The author used an influence machine driven by an electric motor as a generator, and immersed a pear-shaped tube in oil, with the anode outside in the liquid, and not fused into the glass. A spot and a ring are produced opposite the kathode, and the former is deflected as described. As soon as the motion of the electrified body ceases, the spot returns to its first position, after a few oscillations. This phenonemon is quite distinct from the permanent deflection produced by neighbouring conductors.—A simple method of separating alternating discharges in vacuum tubes, by R. Hildebrand. Describes various arrangements of tinfoil and other conductors producing permanent deflection and curvature of kathode rays, such as are usually produced by magnets. Also confirms Jaumann's observations of temporary deflections by electrified rods, but uses an induction coil as a source.—The foundations of electrodynamics, by E. Wiechert. Introduces the conception of a rotor as representing the magnetic displacement instead of a vector, and proves its utility in explaining Röntgen and aberration phenomena.—Some properties of Röntgen rays, by A. Winkelmann and R. Straubel. Attempts to discover refraction by prisms of iron, copper, zinc, silver, lead, and platinum failed. The refractive index of iron for X-rays does not differ more than 0·00005 from unity, and is smaller, if anything. Exposures for shadowgraphs may be considerably lessened by placing the sensitive plate face downwards upon a plate of fluorspar.—Wave-length of Röntgen rays, by L. Fomm. A diffraction experiment gave 0·000014 mm. as the upper limit of the wave-length. This is about fifteen times smaller than the smallest ultra-violet wave-lengths hitherto measured.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 21.—Prof. Raphael Meldola, F.R.S., President, in the chair.—Mr. J. J. Walker exhibited a specimen of *Emus hirtus*, L., taken at Gore Court Park, Sittingbourne, Kent, on May 30 last.—Mr. W. B. Spence sent, from Florence, for exhibition, some specimens of a cricket, *Gryllus campestris*, in small wire cages, which he stated were, in accordance with an ancient custom, sold by the Italians on Ascension-day.—Mr. F. Enock exhibited a specimen of the curious aquatic Hymenopteron *Prestwichia aquatica*, ♀, which Sir John Lubbock, F.R.S., first captured in 1862, but which had not been recorded since that date until its rediscovery in May 1896. Mr. Enock said that the male had remained unknown until June last, when he captured several swimming about in a pond at Epping. The male was micropterous, and, like the female, used its legs for propelling itself through the water.—Mr. Tutt exhibited a beautiful aberration of *Tephrosia bistortata* (*crepuscularia*), in which the ochreous ground-colour was much intensified, and the transverse shade between the median and subterminal line was developed into a brown band; the transverse basal, median and subterminal lines on the fore-wings, and the median and subterminal lines on the hind-wings, being particularly strongly marked in dark brown. Mr. Tutt also exhibited the cocoons, pupal-skin and aberrations of the imago of *Zygæna exulans*. The cocoons were spun upon one another, five in a cluster, and Mr. Tutt stated that the species was exceedingly abundant in the pupal and imaginal stages during the first week of August on the mountain slopes above Le Lautaret, in the Dauphiné Alps, at from 7000 to 9000 feet elevation. The pupa-skin was very similar to those of other Zygænids. The imagines exhibited were all aberrations.—Dr. Sharp, F.R.S., exhibited a caterpillar which had received the eggs of a parasite on the anterior part of the body, the abdomen, nevertheless, went on to the pupal metamorphosis, while the head and thorax remained attached to it in the caterpillar stage. He also called attention to some peculiarities in the pupa of *Plusia moneta*; in this species the pigmentation varies greatly in extent, and is sometimes entirely absent.—Mr. Blandford called attention to the recent discoveries relating to the Tsetse fly, made by Surgeon-Major Bruce in Zululand, which proved that this insect affected animals by injecting them with a parasitic Protozoon. The parasite was communicated from wild animals to domestic animals, and was more widely distributed than was generally believed; it, or a closely allied form, having been found in India and England in sewer rats. He said that Surgeon-Major Bruce had proved that the Tsetse fly was pupiparous, which was of importance as affecting the classification of the Diptera. Dr. Sharp said that in his opinion the Tsetse fly would cease to be troublesome with the advance of civilisation.—Mr. C. G. Barrett exhibited the pupa-skin, cocoon and eggs of *Hesperia comma*, L., found on chalk hills near Reading. He also exhibited and remarked on a series of both forms of *Tephrosia crepuscularia* and *T. biundularia*, showing an unbroken line of variation from brown to white and also to grey and black. In addition, he showed several second brood specimens of both forms obtained in the past summer by Mrs. Bazzett, of Reading.—Mr. Tutt read a paper entitled "On the specific identity of *Cœnonympha iphis* and *C. satyrion*," and exhibited a long series of specimens.—The Rev. T. A. Marshall communicated a paper entitled "A Monograph of British Braconidæ. Part vii."—Mr. T. D. A. Cockerell communicated a paper entitled "New Hymenoptera from the Mesilla Valley, New Mexico."—Mr. E. Meyrick contributed a paper entitled "On Lepidoptera from the Malay Archipelago."—Dr Sharp read a paper by Mr. G. D. Haviland and himself entitled "Termites in Captivity in England.'

Royal Microscopical Society, October 21.—Dr. R. G. Hebb, Vice-President, in the chair.—The diploma and medal awarded to the Society for photomicrographs exhibited at the Columbian Exhibition, Chicago, was laid on the table.—Lieut.-Colonel Siddons exhibited and described a new portable dissecting stand, and also a lens-carrier for use as a dissecting microscope.—Mr. C. Beck made a communication on the new screw-tools for objectives.—Prof. F. J. Bell reported that the microscopes of historical interest belonging to the Society had been exhibited at a conversazione of the Pathological Society, and were now on view.—Mr. J. Butterworth read a paper on a photomicrographic camera designed chiefly to facilitate the study of opaque objects, illustrating his remarks by a series of lantern slides shown on the screen.—Mr. T. Comber read a paper on the occurrence of endocysts in the genus *Thalassiosira*.—Mr. G. Murray detailed some observations made in connection with this subject.—Mr. F. Chapman gave a *résumé* of the ninth part of his memoir "On the Foraminifera of the Gault of Folkestone."—Mr. E. M. Nelson read a paper on a method of measuring the apertures of objectives.

MANCHESTER.

Literary and Philosophical Society, October 20.—Mr. Charles Bailey, Vice-President, in the chair.—Mr. A. Griffiths read a paper on concurrent observations of viscosity and electric conductivity of a salt solution containing gelatine, which was allowed to set slowly at a constant temperature. He finds that the resistance does not appreciably alter even when the viscosity becomes very great. Mr. Griffiths subsequently communicated a note on the resistance of a conducting jelly, containing iron filings, in the magnetic field. He finds that a resistance so constituted becomes less by 25 per cent. in a field of 2000 C.G.S. units.

PARIS.

Academy of Sciences, November 2.—M. A. Cornu in the chair.—On the disaggregation of comets, by M. O. Callandreau. The disaggregation of a comet swarm is found to depend on its density and on the nature of its path, being more marked in an elongated orbit.—The gyroscopic horizon of Admiral Fleuriais, by M. E. Guyou. A description of the adaptation of the gyroscope by the late Admiral Fleuriais for giving the vertical plane at sea. It possesses considerable practical advantages over the pendulum, and is particularly serviceable in places where the horizon is hidden by haze or fog, but where the sun can be seen. The rotation of the earth is clearly indicated by this instrument, and a small correction has to be made on this account.—New researches on the tubercles of the Leguminosæ, by M. C. Naudin. After reviewing the theories of previous workers on the fixation by free nitrogen by the tubercles in the Leguminosæ, the results of experiments are given in which plants were grown from seed in sterilised earth. In many cases the plants germinated five or six days sooner than plants grown in ordinary, non-sterilised earth, and were stronger, greener, and flowered sooner than the latter. The conclusion is drawn that the germs of the tubercle (bacteria, spores, or mycelium) must have been present in the seed or its envelopes. Many of the Leguminosæ, however, are refractory to infection, and it is suggested that the fixation of nitrogen may be a property of the protoplasm of the plant itself.—Note by M. E. Perrier, accompanying the presentation of the fourth part of his "Traité de Zoologie."—M. Duclaux submitted a work entitled "Pasteur, histoire d'un esprit."—On the production of floods, by M. Tarry.—The causes of universal attraction; the ether and the law of gravitation, by M. A. Baudouin.—Surface tension, by M. Langlois.—Note on the satellites attributed to the planet Venus, by M. Triboulet.—Note on storms, by M. Bougon.—On the deformation of surfaces, by M. Paul Staeckel.—Some applications of a theorem, by N. Peterson.—On the theory of partial differential equations of the second order, by M. E. Goursat.—Linear forms of the divisors of $x^2 \pm A$, by M. P. Pepin.—On the gyroscopic horizon of Admiral Fleuriais, by M. A. Schwerer. The results of experiments carried out at sea show that the maximum error in the determination of the altitude of the sun was 2′, while the mean error was less than 1′. After more than forty observations no appreciable wear of the pivot could be detected.—On the Röntgen phenomena, by M. B. Buguet.—On a method of measuring the temperature of incandescent lamps, by M. P. Janet. The method depends upon the assumption that the filament is pure carbon. The total heat lost by radiation between the maximum temperature attained by the filament and that of the air is measured, and the results of M. Violle on the specific heat of carbon are applied to this.—Measurement of the force acting upon non-electrified dielectric liquids placed in an electric field, by M. H. Pellat. Two vessels containing the liquid are connected, one being placed in the field and the other outside of it, and the alteration in the levels measured. The differences observed, which are very small (·06 mm. and under), agree with the calculated figures within the limits of experimental error.—On the heat of formation of lithium hydride, by M. Guntz. The heat of formation was found to be 21·6 calories, a magnitude in keeping with the great stability of the substance. A repetition of the determination of the heat of solution of lithium in water, showed the number previously obtained by Thomsen (49·08 calories) was too low, the correct figure being 53·2 calories. The difference is due to the presence of impurities in the metal used by Thomsen. At its melting point, 680°, the dissociation tension of lithium hydride is about 27 mm., showing a marked difference in this respect from the hydrides of sodium and potassium.—The uniformity of distribution of argon in the atmosphere, by M. Th. Schlœsing. Samples of air from very different sources showed a remarkable uniformity in the percentage of argon, the average value being 1·184 per cent. of the total volume of nitrogen and argon.—On a method of reproduction of double silicates of potassium and other bases, by M. André Duboin.—On French essence of roses, by MM. J. Dupont and J. Guerlain. Whilst samples of French attar of roses of two successive years agreed generally in properties, they differed from a Bulgarian sample in containing more stearoptine.—Development of *Lithocystis Schneideri*, a parasite of *Echinocardium cordatum*, by M. L. Léger.—On a viviparous ephemerid, by M. Causard. Specimens of *Chlæopsis diptera* lived over three weeks after being captured, but in spite of their relatively long life, they do not appear to take more food in the adult state than other ephemerids.—Homology of the anterior segments of some sedentary annelids, by M. Pierre Fauvel.—The use of the X-rays for anatomical researches, by MM. Ch. Remy and G. Contremoulins. By injection of the vascular system with metallic bronze powder, it is made opaque to the X-rays, and in this way it is possible to study the development of bone and teeth with greater certainty and precision than by dissection —On the mode of formation of the Pyrenees, by M. P. W. Stuart-Menteath.—On some quaternary deposits near Eyzies, by M. Emile Rivière.—Note on some properties of numbers, by M. Delauney.—On earth tremors, and on the relations which exist between cyclones and sunspots, by M. Zenger.—On the red colour of vine leaves, by M. Levat.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Laughable Stories collected by Mâr Gregory John Bar-Hebræus, edited, with an English translation, by Dr. E. A. W. Budge (Luzac).—Domestic Science Readers: V. T. Murché, Book iv. (Macmillan).—Round the Year: Prof. L. C. Miall (Macmillan).—An Intermediate Course of Practical Physics: Drs. A. Schuster and C. H. Lees (Macmillan).—Electro-Physiology: Prof. W. Biedermann, Vol. 1, translated by Miss F. A. Welby (Macmillan).—The Capillary Electrometer: G. J. Burch, Part 1 (Tucker).—Submarine Cable Laying and Repairing: H. D. Wilkinson (*Electrician* Company).—The Tears of the Heliades, or Amber as a Gem: W. A. Buffum (Low).—Chemical Lecture Experiments: G. S. Newth, new edition (Longmans).—Lehrbuch der Erdkunde: Dr. W. Ule, ii. Teil (Leipzig, Freytag).—Allgemeine Erdkunde: Dr. J. Hann, 1 Abtg. (Wien, Tempsky).—Geological Survey of Canada, Annual Report, 1894 (Ottawa).—Feathered Friends, Old and New: Dr. W. T. Greene (U. Gill).—University College of North Wales, Calendar for the Year 1896-97 (Manchester).—A Junior Course of Practical Chemistry: F. Jones, new edition (Macmillan).—A Short History of Aryan Medical Science: H.H. Sir B. Sinh Jee, Thakore Saheb of Gondal (Macmillan).—Problems of Biology: G. Sandeman (Sonnenschein).—The Clue to the Ages: E. J. Page. Part 1, Creation by Principle (Baptist Tract and Book Society).—A Manual of Quantitative Chemical Analysis: Cairns and Waller, 3rd edition (New York, Holt).—The Human Body: Dr. H. N. Martin, 7th edition (New York, Holt).—General Principles of Zoology; Prof. R. Hartwig, translated by Prof. G. W. Field (New York, Holt).—University College, Nottingham, Calendar 1896-97 (Nottingham, Sands).—Fridtiof Nansen: W. C. Brögger and N. Rolfsen, translated by W. Archer (Longmans).

PAMPHLETS.—Physical Science and the First Chapter of Genesis: Prof. H. E. Ryle (Macmillan).—Knight's Diagramettes, Hygiene (Chapman).—The Whales and Dolphins: Prof. R. J. Anderson, Part 2 (Belfast, Mayne).

SERIALS.—Natural Science, November (Page).—Longman's Magazine, November (Longmans).—Chambers's Journal, November (Chambers).—Lloyd's Natural History. Mammals, Parts 1 and 2: R. Lydekker (Lloyd)—The History of Mankind: F. Ratzel, Part 13, translated (Macmillan)—Bulletin of the American Mathematical Society, October (New York, Macmillan).—Century Magazine, November (Macmillan).—Contemporary Review, November (Isbister).—National Review, November (Arnold).—Fortnightly Review, November (Chapman).—Hypnotic Magazine, September (Chicago).—Journal of the Royal Microscopical Society, October (Williams).—Académie des Sciences de L'Empereur François Joseph I., Bulletin International. Médicine, I.; Sciences Mathématiques et Naturelles, I. (Prague).

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