THURSDAY, APRIL 3, 1902.

ELASTICITY FOR ENGINEERS.

Résistance des Matériaux et Éléments de la Théorie mathématique de l'Élasticité. Par Aug. Föppl. Traduit par E. Hahn. Pp. 490. (Paris: Gauthier-Villars, 1901.) Price fr. 15.

DISCUSSIONS as to the amount of "learning of mathematics" necessary for the engineer have not been confined to this country, but have, as we learn from the preface, been keenly carried on in Germany. There appears to be a desire in some quarters to sacrifice mathematical teaching to laboratory work, on the ground of the great increase in the number of hours necessary for the latter in consequence of modern developments of electrotechnics; and some writers have attempted to bring forward as an argument the rarity of the occasions on which mathematics is required by the engineer, and the large amount of time that is required to obtain a knowledge of that subject.

Prof. Föppl takes an entirely different view. While admitting that no advantage is gained by the study of purely speculative branches of mathematics, he is directly opposed to any tendency to lower the general level of mathematical knowledge of our future engineers. He lays stress on the value of mathematical training in enabling the practical man to *draw correct conclusions* on the numerous questions on which he is required to pronounce judgment, even where actual calculations are not required.

This is a view which ought to be more keenly appreciated among practical men than has been the case hitherto, and we should like to see put forward an entirely opposite suggestion to that which has apparently found favour in some circles in Germany, namely that *more* attention should be given to mathematics in the training of engineers *even* at the expense of laboratory work. It is sufficient to take up any volume of engineering transactions to find the "practical" man "plunging" into pages and pages of elaborate formulæ involving "shines and coshes," and in the end either getting no result of interest, or obtaining a simple deduction of some principle well known to every mathematician, but which the writer of the paper puts forward as if it were a new physical law. On the other hand, the engineer who has an intimate knowledge of pure and applied mathematics will know, for example, what partial differential equations are involved in the solution of any problem placed before him, and even if he knows that it is impossible to solve these for the particular type of boundary with which he has to deal, he will form a complete mental picture of the machinery underlying the system he is investigating; he will mentally classify the known and unknown quantities involved in the problem, and will see at a glance the right lines on which to determine the unknown quantities experimentally, instead of spending hours in floundering through formulæ or wasting money over superfluous experiments.

The theory of elasticity probably enters into the work of the engineer more intimately than any other branch of applied mathematics, and, at the same time, there are few subjects so difficult to present to the learner in a form that will furnish him with a definite mental picture of the phenomena concerned. So far as we are aware, no one has, as yet, ever attempted to construct diagrams of the deflections of a rectangular sheet of steel plating by dotting it over with microscopists' cover-glasses, silvered on the back, allowing these to reflect light from a source on to a screen and observing or photographing the displacements of the bright spots when one side of the plate is submitted to pressure or a weight is applied at any point of its surface; yet this would not be difficult to do, and would certainly give interesting results.

The present work is the French translation of a book written by Prof. Föppl expressly for the purpose of giving engineers an insight into the mathematical theory of elasticity. It commences with a chapter on the analysis of stresses, which we regret to see entitled "Forces intérieures ou actions moléculaires." When will writers adopt some consistency in their use of the words *molecule* and *molecular?* In text-books on hydrodynamics, the term *molecular rotation* is often found applied to a quantity which by no means represents the rotation of the actual molecules of the fluid, but is merely the curl of the velocity. Thus it follows that the "molecular rotation" of Basset and other text-book writers vanishes when a fluid is moving irrotationally, while the kinetic theory of gases tells us that in a mass of gas *at rest* the molecules are in rapid rotation, the kinetic energy of the true molecular rotation bearing a determinate ratio to that of molecular translation, except probably in the case of a monatomic gas. Similarly M. Föppl takes no account of the molecular structure of the body, there is no reference to Boscovich's or any other hypothesis, and his "molecular" actions, so-called, are nothing more or less than the ordinary stresses in the element $dx\ dy\ dz$. Seeing that $dx\ dy\ dz$ is called an element, why not consistently use the term "elemental" or "elementary" for such actions? In the next chapter, which deals with analysis of *strain* as opposed to stress, this is done, the nomenclature "déformations élémentaires" being adopted. This chapter contains discussions on the elastic limits, Woehler's experiments and diagrams of the relations between stress and strain beyond the limits of Hooke's law. The third chapter is devoted to flexure of beams, and it includes digressions on moments of inertia and the method of finding them with a planimeter. Of graphical interest is the diagram showing the enveloping curves of the lines of stress (p. 120). The next chapter deals with the potential energy of deformation, and includes Castigliano's interesting theorems and Maxwell's reciprocal property.

Chapter v. deals with curved beams or prisms, and the next chapter with the problem (prisms resting on a compressible base) presented by the yielding of railway metals under the weight of a train. This is followed by a chapter on the plane plate, after which come thin and thick shells. The ninth chapter deals with the torsion problem. The solution for a rectangular beam is, however, wrong. The author finds stress components represented by algebraic expressions of the third degree, and shows that these satisfy the stress-equations, but he omits to show that these expressions are compatible with the strain-equations—professedly in order to obtain as simple a result as possible, even if approximate, but really because his is not the correct solution of a problem, that obtained by Saint Venant's method involving series of transcendental functions. We miss the well-known equilateral triangle and the algebraic solutions representing sections approximately square. Chapter x. deals with the collapse (*flambement*) of beams under end thrust or torsion.

"The elements of the mathematical theory of elasticity" is the title of the last chapter. In it the differential equations of elasticity are expressed in terms of the displacements, and the applications include wave-propagation, Saint Venant's torsion problem (still without reference to the rectangle or equilateral triangle), Boussinesq's and Hertz's theorems.

A special feature of the book is the collection of examples at the end of each chapter. These, of which the solutions are given, are, as examples should be, mostly straightforward applications, frequently numerical, of the bookwork, and though some of them are necessarily rather long, none of them are without some practical interest. It is very likely that many a mathematician brought up on tripos riders might find the numerical calculations puzzling at first, but is it not essential to understanding a theory properly that it should be tested by numerical examples and not merely by "neat analytical results"? Another feature is the synopsis of formulæ at the end of the book.

This is not exactly the book which a mathematician would use to learn elasticity from by preference, but then it was not written for mathematicians. In endeavouring to present the theory of elasticity in the most practical aspect possible so as to bring it within the range of engineering students, the author appears to have achieved his object with remarkable success, or in the conventional words of the reviewer, "this book is admirably adapted to the requirements of the class of readers for whom it is specially written."

DETERMINATIVE BACTERIOLOGY.

A Manual of Determinative Bacteriology. By Frederick D. Chester. Pp. vi + 401. (New York: The Macmillan Company, 1901; London: Macmillan and Co., Ltd.) Price 10*s.* 6*d.* net.

ALL branches of science in the early stages of their development suffer from the want of a uniform nomenclature. But it is in the biological sciences, especially zoology and botany, that the greatest confusion has prevailed, more particularly in the naming of the multitudinous forms of animal and plant life. Thanks, however, to the codes of rules drawn up at various conferences, and more or less universally accepted, the systematic nomenclature of zoology and botany has become much more uniform and simple, while these branches both possess a recognised terminology for descriptive purposes.

It is otherwise with bacteriology. This science, though primarily a branch of botany, has been mainly developed by those who could not claim to be trained botanists, and the bacteria have been studied and classified with little reference to the relations existing among themselves and to allied forms; hence the nomenclature, both systematic and escriptive, is in a chaotic state. Moreover, descriptions of new forms are continually appearing in a number of journals, so that it is extremely difficult without an enormous expenditure of time to discover whether a form has previously been described or no, as hitherto there has been no catalogue of species available. It is with a view to purge bacteriology of some of these reproaches that the present work has been compiled. The author modestly states in the preface that he "does not claim that the system of arrangement is perfect. . . . The present tables serve, therefore, only for purposes of identification and not necessarily for those of classification." The opening chapter is devoted to an account of the morphology and biology of the bacteria; in the second a genuine attempt is made to devise a system of terminology for descriptive purposes. The various forms of growths, of colonies, &c., receive appropriate names, so that what was formerly a long description may be condensed into a few words. For instance, the gelatin stab culture of anthrax is "an arborescent growth becoming a crateriform to saccate liquefaction," and the agar colonies of the same organism are simply "floccose." The preparation of standard nutrient media is then described, a reaction of + 0·5 being preferred to that of + 1·5 adopted by the Committee of the American Public Health Association. Some staining methods are next briefly mentioned, and a few pages are devoted to a study of the chemical functions of bacteria, a table of chemical separations, and a scheme for the study of bacteria.

In chapter iii. the classification of the bacteria is dealt with, that adopted being on the basis of the one described by Migula in his "System der Bakterien," and the various species are tabulated at length and upon a definite scheme. This portion of the book occupies more than 300 pages and must have entailed considerable labour in its compilation. The cultural and other characters of each organism are described upon a consistent plan, while the various species are divided up into small groups by certain prominent characteristics, such as chromogenic, liquefying, Gram-staining and other properties. By this subdivision, and the synopsis of characters given before each group, it is possible, as the author points out, to place a culture in the hands of a student and for him to determine the species. Those who are acquainted with the older works of Eisenberg, Lustig, &c., will accord a hearty welcome to these tables. The classification, as stated before, is that of Migula, but the nomenclature of species has been made to accord with the rules of botanical nomenclature, with a rigid insistence upon binomial names and upon the rule of priority. At the same time, the synonymy of, and earliest reference to, each species is given. This is no doubt a great advance, though perhaps inconvenient at first, as it involves the renaming of a number of familiar species, sometimes with far less appropriate names than they have at present. For example, the bacillus of mouse septicæmia was conveniently termed the *Bacillus murisepticus* by Flügge in 1886, but a year previously Trevisan had named it the *Bacterium insidiosum*, and therefore "*insidiosus*," by the rule of priority, must stand as the specific name. Curiously enough, having discussed this very organism as an example of the rule of priority at length at p. 48, when it comes to the actual description of it (p. 353) the author tabulates it as *Mycobacterium murisepticum* instead of "*insidiosum*," as, from his own showing, it should be. Similarly, the bacillus of hog cholera, the *B. suipestifer*, Kruse, becomes the *B. Salmoni*; the organism of chicken cholera the *B. cholerae*; Koch's comma bacillus of cholera *Microspira comma*, &c.

In a work which as a whole is so excellent, it would be invidious to criticise minor points, and the following remarks should therefore be regarded as suggestions for amendment in a future edition.

The description of the *Bacillus enteritidis*, Gärtner, is too brief, and this organism does not ferment lactose. All peritrichic forms are indicated by a "B" in heavy type. Those which are presumably so, but about which there is no definite information, are designated by a "B" in lighter type; the distinction between the two letters should be made more marked. The *B. Welchii* and *B. emphysematosum* (p. 183) are, according to Welch, identical. In places the terminology needs revision, *e.g.* *M. eczemae* (p. 86) and *M. epidermis* (p. 62). The reviewer has searched in vain for any mention of the *Micrococcus melitensis*.

While the index is a very full one, it might be yet more complete with advantage—for example, in all cases both the ordinary name and the one adopted should be given, but this is not done. Anyone searching for the *M. agilis* would not find it unless he knew that the organism was flagellated and belonged to the genus Planococcus. There is no reason why "Bacterium" should be indexed before "Bacillus." The *B. aërogenes capsulatus* is wrongly indexed (p. 269, instead of p. 183). The work concludes with a glossary of terms and a short bibliography. As regards the latter, one reference reads "Trevisan-de-Toni, &c."; it should be "Trevisan *and* de Toni in, &c." Moreover, another work by Trevisan, "Gen. e spec. delle Batteriaceæ" (1889), although frequently alluded to in the text, is not mentioned in the bibliography.

R. T. Hewlett.

STRATIGRAPHICAL GEOLOGY.

The Student's Handbook of Stratigraphical Geology. By A. J. Jukes-Browne, B.A., F.G.S. Pp. xii + 589. (London: Edward Stanford, 1902.) Price 12*s.* net.

As stated in the author's preface, "this volume is based upon the 'Student's Handbook of Historical Geology' published by Messrs. G. Bell and Sons, and may be regarded as a second edition of that book." It has been entirely rewritten, however, and brought up to date; moreover, the alterations and additions are so numerous and important that to describe it without qualification merely as a second edition of that work is, we think, to give a wrong impression of its increased merits.

The former book, which was published in 1886, was in most respects an excellent work and contained a surprising amount of information; but, in our opinion, it had a serious defect. It was somewhat lacking in interest, dry, and not very readable. Fortunately for the student, this fault, which it is very difficult, often impossible, to avoid when, as in this case, the information to be imparted consists in the main of the statement of a host of details, has in the present volume been largely remedied; and the author is to be congratulated upon the manner in which, while greatly augmenting the number of recorded facts, he has succeeded in maintaining the general interest of his subject.

Of the eighteen chapters which comprise the text of the volume, the first four deal with the principles involved in the science of stratigraphy. They follow the same general plan as was previously adopted. The fifth, however, is quite an innovation. It gives information to the student as to the principal works on general stratigraphy which are available in this country, and as to the facilities which exist for ascertaining what has been published, in the way of maps and special treatises, concerning the stratigraphical geology of any district in the British Isles of which he may wish to acquire a deeper knowledge. It should prove especially useful to students who are self-taught.

The remaining chapters are devoted to the study of the several geological systems, which are taken, as before, in the ascending order. The nomenclature adopted for the systems is simple and satisfactory. The substitution of the terms Palæogene and Neogene, originally suggested by Hœrnes for the Tertiary systems and now widely employed on the continent, in place of the terms Hantonian and Icenian used in the first edition, is, we think, an improvement in terminology. The chapters dealing with the Palæozoic systems have been very considerably expanded, with the result that these systems now receive a fairer share of attention than was the case in the first edition.

The author has adopted a capital plan of placing the literature-references at the end of each chapter, where, with the addition of such others as are necessary to make the list tolerably complete, they constitute a most useful bibliographical index of the subject dealt with in the chapter.

The main bulk of the book treats of British stratigraphy. Such accounts as are given of foreign rock-groups are comparatively short, and, except in a few special cases, are confined to those of the European continent. This, to some extent, limits the use and value of the book; but to us it seems that the author has done well to make his description of foreign strata quite subordinate to that of beds at home which every student has the opportunity of seeing and examining in the field for himself. In order to have included a satisfactory treatment both of British and foreign stratigraphy it would have been necessary to increase the size of the volume to such an extent that its cost would be prohibitive to most of those for whom it is especially written.

One of the greatest improvements in the book in its new form is the addition of a number of sketch-maps illustrating the geology of many of the more specially interesting districts in England and Wales. These, which are in part derived from previous publications and in part have been prepared for the work, from the maps of the Geological Survey, are clearly and effectively drawn, and greatly facilitate a ready comprehension of the text. The author's suggestion that the student should tint them with suitable washes of colour is a good one; the exercise intelligently carried out, besides enhancing the value of the diagrams, should also serve to impress the geology of each district more permanently upon his mind.

The number of explanatory geological sections has been considerably increased, and the same is true of the figures of fossils. The volume is, indeed, admirably illustrated. It is an important and welcome addition to the list of English treatises which are especially designed for the use of the student of stratigraphical geology, and one which we can most confidently recommend, not only to students, but to all who desire a trustworthy representation of the present state of our knowledge of British stratigraphy.

OUR BOOK SHELF.

Birds' Nests, an Introduction to the Science of Caliology By Charles Dixon. Pp. xiv + 285; illustrated (London: G. Richards.) Price 6*s*. net.

IF we may judge from a statement on p. 7, Mr. Dixon is of opinion that stone-throwing is a proper and suitable practice for the tenants of glass houses. For since he classes Darwin as a "compiler," he can scarcely have the presumption to exclude himself from the same category! As a matter of fact, Mr. Dixon's works are to a great extent compilations from the writings or observations of others, and the present volume appears to be no exception to the rule.

That popular works of the class of those for which Mr. Dixon is responsible must almost necessarily contain a large percentage of copied matter we are fully prepared to admit, but when the author of such works sees fit to refer in contemptuous terms to one of the master minds of the last century he must not be surprised if critics treat his own productions and methods with scant courtesy.

In the volume before us, Mr. Dixon claims to have opened up a practically new branch of ornithology, which he designates, very unnecessarily, as "caliology." He further states that no work has been entirely devoted to this subject for the last seventy years. In this it may be taken for granted that he is correct, although it would be a mistake to suppose that other writers have not devoted a considerable amount of attention to the subject. Indeed this is evident from the work itself, in which the author quotes the views of Dr. A. R. Wallace, Dr. E. Goeldi and other eminent zoologists. Mr. Dixon has the knack of putting what he has to tell in an agreeable and attractive manner before the public, and had he not gone out of his way to cast a slur on the reputation of a great man we should have been more inclined to bestow a modicum of praise on his efforts than we feel justified in doing as matters now stand.

The plan of the work is to describe the nest-building of birds in a progressive manner, commencing with those species the nests of which are of the simplest type (or rather with those which make no nests at all), and gradually passing on to those, such as the tailor-birds and hang-nests, which construct nurseries of the most elaborate type. Mr. Dixon is one of those who believe that the nest-building instinct is not inherited and that birds learn to build by practice and instruction. He considers this belief to be strengthened by the case of a nest (which he figures) built by a pair of chaffinches taken to New Zealand before their first nesting season. The nest built by them in the antipodes is of a very abnormal type; but is it certain that this may not be accounted for by difference of environment and material? Another plate, in which the bird is depicted in a very remarkable posture, shows the eggs of a greenshank in the deserted nest of a fieldfare. We may say in conclusion that those who have never previously studied birds' nests with attention will find much to interest them in Mr. Dixon's latest volume.

R. L.

Lancashire Sea-Fisheries Memoir. No. 2, *Fish and Fisheries of the Irish Sea.* By W. A. Herdman, D.Sc., F.R.S., and Robert A. Dawson. Pp. 98. (Liverpool: Philip.) Price 5*s*. net.

IN the second of the Lancashire Sea-Fisheries Memoirs, Prof. Herdman and Mr. Dawson summarise, for the use more especially of the members of the Lancashire and Western Sea-Fisheries District Committee to whom the volume is dedicated, the more important results bearing upon practical fishery questions which have been obtained from the scientific researches carried on during recent years in the Irish Sea. The information given is for the most part not new to the scientific student, as it has already been made known through the various reports of the Liverpool Biological Society.

The work commences with a useful account by Prof. Herdman of the physical and biological conditions which are found in the Irish Sea, more especially in that part of it which lies between the Isle of Man and the Lancashire Coast. This account includes some interesting information, supplied by Mr. Clement Reid, on the geological features of the bottom deposits obtained from different parts of the area under consideration.

After a brief description of the invertebrate fauna, a complete list of the fishes of the district is given, with details of the geographical and local distribution of each species. It is to be regretted that more information as to the habits and life-histories of the various fishes is not supplied in this portion of the work, as such information would have rendered it both more interesting and more useful to those for whom it is intended.

The memoir concludes with a chapter by Mr. Dawson on the constitution and work of the Lancashire and Western Sea-Fisheries Committee and two appendices, one containing the bye-laws of the Committee and the other some detailed results of various experimental hauls of the trawl.

Plant Structures. By John M. Coulter, A.M., Ph.D. Pp. vii + 348. (London: Hirschfeld Brothers, Ltd., 1901.) Price 6*s*. net.

FORMER books by the professor of botany in the University of Chicago have been characterised by a concise and rational elucidation of the subjects treated, and this applies also to the book under discussion. In "Plant Relations," a first book on botany, Prof. Coulter dealt mainly with ecological factors. "Plant Structures" gives a brief outline of the various great groups of the plant kingdom. The life-histories of common or important types are used to illustrate the gradual transition from the lowest algal plants to the complex, highly modified group of spermaphyta, and also to introduce the student to the widely varying structures and methods of reproduction which obtain among plants. The types chosen are, for the most part, similar to those found in other elementary text-books; a new ascomycetous type is furnished by *Microsphaera*, a mildew which occurs on lilac leaves. In addition, many other interesting examples are quoted and, to a great extent, illustrated; in fact, there is an almost superabundant wealth of illustration.

It cannot be said that the author has struck any original vein, but the strength of the book lies in clear and sound representation of facts, and in logical sequence of argument; also, where it is appropriate, the result of recent work has been embodied, as, for instance, the occurrence of sperms in the Cycads, and chalazogamic fertilisation in the Dicotyledons, for which original illustrations are given. The author is especially happy in his treatment of the Angiosperms as he traces the various evolutionary series of floral modifications. There are two points in which there will not be general agreement with the author; the term "spore" is not confined to sexual reproduction, but the result of fusion of ovum and sperm is also defined as a spore; again, how can the spelling of *Edogonium* be made to accord with its derivation?

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.*]

Magic Squares of the Fifth Order.

IN the interesting discourse reproduced in your issue of March 13 (p. 447), there is a statement that the number of magic squares of order 5 exceeds 60,000. Major MacMahon informs me that he gave these figures on the authority of Rouse Ball's "Mathematical Recreations." The statement is not wrong, but viewed as a minimum limit it may be largely exceeded. I have recently investigated the total number of squares of this order, which have the additional property that the nine numbers in the heart of the square also form a magic—the well-known "bordered squares." Fig. 1 is an example. The square itself is magic in rows, columns and diagonals, and the nine numbers in the central square show like properties.

It is easy to see (1) that the numbers in the central square must consist of three arithmetical progressions with a like common difference; (2) that the first terms of each progression must also be in arithmetical progression; and (3) that the mean number (13) must always occupy the central cell. Hence it follows that (excluding the central number) the eight numbers in the heart must consist of four pairs of complementary numbers (*i.e.*, pairs whose sum is 26, or twice the mean), and also that the two smallest numbers being known, then all the others are known. If, for example, the two lowest numbers in the heart are a, $a+k$, then the nine numbers in the centre, taken in numerical order, must be a, $a+k$, $a+2k$; $13-k$, 13, $13+k$; $26-2k-a$, $26-k-a$, $26-a$. It is now easy to determine in how many ways we may choose the nine numbers for

2	25	23	10	5
14	11	22	6	12
19	8	13	18	7
9	20	4	15	17
21	1	3	16	24

FIG. 1.

5	25	24	4	7
11	10	23	6	15
12	9	13	17	14
18	20	3	16	8
19	1	2	22	21

FIG. 2.

the centre on the usual assumption that we are restricted to the first 25 natural numbers without repetition or omission. The total is 26, as shown in the first column of the table below, where the figures in brackets denote the two lowest numbers in the heart.

Type.	Number of subtypes.	Type.	Number of subtypes.
A. (1, 2)	28	N. (4, 5)	30
B. (1, 3)	31	O. (4, 6)	23
C. (1, 4)	18	P. (4, 8)	30
D. (1, 6)	21	Q. (5, 6)	16
E. (2, 3)	30	R. (5, 7)	20
F. (2, 4)	30	S. (5, 8)	20
G. (2, 5)	26	T. (6, 7)	19
H. (2, 6)	29	U. (6, 8)	18
I. (2, 7)	23	V. (6, 9)	28
J. (3, 4)	23	W. (7, 8)	19
K. (3, 5)	23	X. (8, 9)	29
L. (3, 6)	13	Y. (8, 10)	18
M. (3, 7)	27	Z. (9, 10)	10
TOTAL			... 602

These we may call the 26 main types of bordered squares of the fifth order. The 16 remaining numbers have evidently to be arranged in the four borders in such a way that complementary pairs are opposed at the opposite ends of rows, columns, or diagonals, with the additional condition that the four borders must each sum 65. Now when we deal a pair of complementary numbers into the top and bottom rows, we clearly give to those rows a difference equal to the difference of the complementary pair. If we call this a "complementary difference," then the numbers in the two rows must be so related that the sum of two complementary differences must equal the sum of the other three, and a similar relation must hold between the two lateral borders. Suppose we are dealing with type L. (3, 6). The numbers for the centre are 3, 6, 9; 10, 13, 16; 17, 20, 23. If now we arrange the remaining numbers in two columns, with complementaries adjacent, and form a third column of half differences, we have :—

		Half Difference.
1	25	12
2	24	11
4	22	9
5	21	8
7	19	6
8	18	5
11	15	2
12	14	1

It is then necessary to form two equations from the column of half-differences of the form $a+b=c+d+e$, and so related that two and only two numbers shall be common to both equations, and that these two shall be on opposite sides of the equality sign in one equation, and on the same side in the other. In the case of type L. we can do this in thirteen different ways, as shown below, the italicised figures denoting the corner pairs :—

$$\left.\begin{array}{l}12+11=9+\mathit{8}+\mathit{6}\\ \mathit{6}+5=\mathit{8}+2+1\end{array}\right\}a. \qquad \left.\begin{array}{l}12+\mathit{8}=9+\mathit{6}+5\\ \mathit{8}+\mathit{6}=11+2+1\end{array}\right\}b.$$

$$\left.\begin{array}{l}12+\mathit{6}=9+\mathit{8}+1\\ 11+5=\mathit{8}+\mathit{6}+2\end{array}\right\}c. \qquad \left.\begin{array}{l}12+6=\mathit{9}+8+\mathit{1}\\ \mathit{9}+5=11+2+\mathit{1}\end{array}\right\}d.$$

$$\left.\begin{array}{l}\mathit{12}+5=9+\mathit{6}+2\\ 11+8=\mathit{12}+\mathit{6}+1\end{array}\right\}e. \qquad \left.\begin{array}{l}12+5=9+\mathit{6}+\mathit{2}\\ 8+\mathit{6}=11+\mathit{2}+1\end{array}\right\}f.$$

$$\left.\begin{array}{l}12+2=8+\mathit{5}+\mathit{1}\\ 11+\mathit{5}=9+6+\mathit{1}\end{array}\right\}g. \qquad \left.\begin{array}{l}12+\mathit{1}=6+\mathit{5}+2\\ 9+8=11+\mathit{5}+\mathit{1}\end{array}\right\}h.$$

$$\left.\begin{array}{l}\mathit{11}+\mathit{9}=12+6+2\\ \mathit{9}+8=\mathit{11}+5+1\end{array}\right\}i. \qquad \left.\begin{array}{l}11+9=12+\mathit{6}+\mathit{2}\\ \mathit{6}+5=8+\mathit{2}+1\end{array}\right\}j.$$

$$\left.\begin{array}{l}\mathit{11}+8=12+6+\mathit{1}\\ 9+5=\mathit{11}+2+\mathit{1}\end{array}\right\}k. \qquad \left.\begin{array}{l}\mathit{11}+8=12+\mathit{5}+2\\ \mathit{11}+\mathit{5}=9+6+1\end{array}\right\}l.$$

$$\left.\begin{array}{l}11+5=8+\mathit{6}+\mathit{2}\\ 9+\mathit{6}=12+\mathit{2}+1\end{array}\right\}m.$$

Each of these 13 pairs yield a subtype under type L. For example, take the first pair. The first equation tells us that the greater of the two pairs of numbers whose half-differences are 12 and 11 can be associated in one border with the lesser of the three pairs whose half-differences are 9, 8 and 6, the complements, of course, being opposed in the opposite border. The other equation gives similar information regarding the other two opposed borders. The centre can be arranged at once by following the order of the ordinary magic of the third degree. The result is shown in Fig. 2.

The table above gives the number of subtypes for each main type, the total being 602. The result has been verified by another worker independently.

It is now easy to calculate how many bordered magics of the fifth order exist. The centre for a given subtype we know can be arranged in one way only if reversions and reflections are *not* reckoned as different; in eight ways if they are so reckoned. Consider the top row in any one of the 602 subtypes. For the left-hand corner we have four choices, for the next cell six, and for the third cell two. This leaves three choices for the second cell of the left-hand border and two for the third. The numbers in all the remaining border cells are now known. There are, therefore, $4\times6\times2\times3\times2=288$ ways of arranging the borders for each sub-type. The total number of squares is thus $602\times288\times8$ if reversions and reflections are reckoned as different; $602\times288=173{,}376$ if they are not so reckoned.

When we bear in mind that this is the number of magics of a restricted type, it is clear that the number of magics of the fifth order must largely exceed this total; indeed, everything suggests that the totality of magics of the fifth order is more than twice as great as the above result. C. PLANCK.

Haywards Heath, March 15.

Rotation of a Lamina Falling in Air.

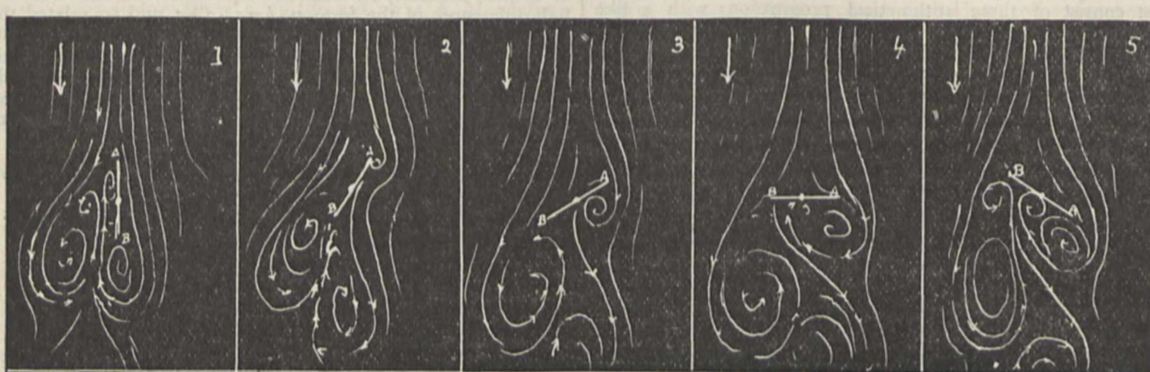
IN your issue of March 20, Dr. Johnstone Stoney, in reference to the behaviour of ice spiculæ in the clouds, instances the spinning of a card when dropped through the air.

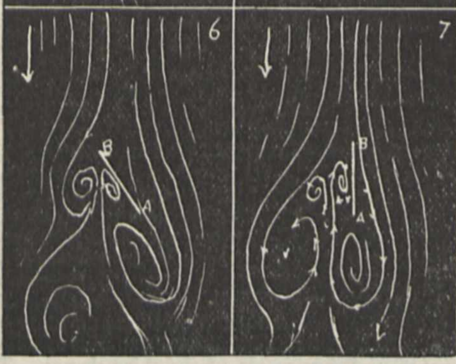
I think Lord Rayleigh was the first person to point out how curious this phenomenon is and to show that the axis of a spinning lamina might be held between bearings without affecting the result. Also that a lamina so held and placed in a draught was equally ready to spin in either direction, thus precluding the idea that the rotation might be due to some want of symmetry in the lamina itself.

A few years ago I made some experiments on the rotation of laminæ in air currents.

The laminæ were mounted in bearings as frictionless as I could make them, and the experiment consisted (*a*) in measuring the speed of the air and the angular rotation of the lamina, (*b*) in mapping the flow of the air past the lamina. This was done by the use of smoke and intermittent illumination.

It would take too long to describe the apparatus in detail, but some of the results may be of sufficient interest for publication.





Sketches of the position of the eddies formed in the neighbourhood of a rotating lamina, A B.

Thus, the angular velocity of the lamina was found to be (through a considerable range of air speed, v, and breadth of lamina, b) = constant $\times \frac{v}{b}$.

There is a limit, however, to the smallness of the lamina which will revolve (*e.g.* small laminæ of gold-leaf a tenth of an inch long and two or three hundredths broad do not revolve, but oscillate as they fall).

The cause of the rotation depends on the way in which the eddies are formed on the downstream side of the lamina.

The changes which occur, in the eddy making, during half a revolution are shown in the accompanying sketches.

From these it will be seen that the spin causes the air to flow unsymmetrically with regard to the axis of the lamina, and that there will be, on the whole, a transverse force on the axis tending to press it in the direction of rotation of the leading edge.

It can be seen also that *before* the lamina reaches the positions 1 or 7, there will be a couple acting on it tending to accelerate the rotation, and that the couple will certainly be positive from position 1 to 3. It may be negative from between positions 3 and 4 to 6; but at any rate for more than half the total time the rotation is being accelerated.

To calculate the magnitude of the couple *a priori* is, I believe, beyond the power of mathematical analysis at present.

The experiments just alluded to were made with light rectangular laminæ, but these conditions are not essential—pennies spin very nicely when dropped from a great height.

I have not succeeded in making a lamina spin in a current of water, probably because the densities of the fluid and solid are not sufficiently different, but if a flywheel were fixed on the axis of the lamina, so as to be out of the water, and thus increase the moment of inertia of the turning body without altering the fluid friction, &c., rotation might perhaps be obtained in this case also. A. MALLOCK.

March 22.

Mathematics and Science at Cambridge.

To those who have at heart the advancement of scientific knowledge in Great Britain it is impossible but to acknowledge that the country owes a profound debt of gratitude to the University of Cambridge. During the dark ages of education her colleges formed the stronghold of modern culture; and the principle was there maintained that to the students of dead languages, however paramount they might be without her walls, within them no more than equal rights should be conceded. This involved a contest in which the principals were the mathematicians and classics, and the terms of peace a system of specialisation coupled with a certain test examination, an inquisitorial farce known as the Little-Go. This system, adopted doubtless in order to obviate the difficulty of forming a combined curriculum of studies which appealed to totally dissimilar tastes, has since been so widely extended in its application as to divorce subjects which are germane in character and naturally adapted for a close alliance. The climax is reached in the ever-growing barrier which separates mathematics from natural science, and which is year by year made more impassable by the examinations for entrance scholarships. These are of high value; and without this aid from the funds which the college authorities hold in trust for educational purposes many a brilliant man would be unable to consummate his work at school by a university career. It is, therefore, necessary that school curricula should be arranged in strict accordance with their requirements.

In view of their future careers, schoolboy mathematicians are divisible roughly into three classes—those who will make a profession of mathematics, those who will apply mathematics to science, and those who will, after obtaining academic honours, entirely sever their connection with the subject. To the last of these the question of syllabus is of comparatively small importance. But to the first and second it is of the utmost importance, and especially to the second, as it is essential to a man who for several years studies mathematics with an ulterior object in view that, while he should acquire a thorough grasp of the principles of the subject, he should not be forced by examining bodies to apply himself to what can only be regarded as intellectual pastimes: nor even in the case of the first can great skill in work of this class rank *pari passu* with a grasp of principle.

Consider the case of an able schoolboy who makes mathematics his chief study between the ages, say, of fifteen and nineteen; this period should suffice to give him a working knowledge of three-dimensional analysis, integral calculus and differential equations with their applications to the mechanics of solids, in addition to the subjects now required by the colleges, were it not for certain side issues which have arisen from the latter and assumed stupendous proportions. Foremost among these stands the excessive measure of attention given to the analysis of curves of the second degree. These form naturally a small section in a treatise on analytical geometry; yet while the far-reaching principles of the latter are lightly passed over, there is scarcely a method so abstruse or an artifice so petty that it may not give rise to a question in an entrance scholarship paper if its bearing be upon conic sections; so that no less than a third of a schoolboy's mathematical hours are frequently sacrificed to these curves. Their real interest is due, firstly, to their appearance in astronomy (the properties there required are few, and might be treated in the appendix of a text-book on dynamics), and, secondly, to their adaptability to treatment by pure geometry, the direct methods of which lend them an interest which is alien to every other branch of mathematics, and supply a mental discipline which is elsewhere unattainable. On this alone rests their title to rank as a separate subject.

But this, though the most aggravated, is not the only instance of the kind. The time spent on advanced trigonometry is out of all proportion to its practical or educational value; the subject contains an introduction to the use of the complex quantity which properly forms part of the theory of functions, and includes a number of highly specialised problems which have no place in a syllabus so elementary as to exclude the integral calculus. A similar waste is caused by several large classes of questions, especially some on series, the ability to solve which implies nothing but an effort of memory, and by other fragments of high subjects which are thrust upon boys at an early stage and made artificially difficult by isolation from their proper context.

The above criticisms are not made in any spirit of hostility to examiners, who in framing their papers are trying to obviate the shortcomings of a system which is out of date and in need of radical reform. Five decades ago it was doubtless advisable, in view of the then state of school mathematics, to limit the entrance scholarship course to a few subjects, but under new and improved conditions is not an extension of syllabus preferable to the interweaving with these of a quantity of matter which, valuable as it may be to the problem setter, is for the student little else than a barrier to his progress?

But if the examinations in mathematics and science are to be brought into harmony, it is not only in the former that a new regime is needed. Under present conditions a boy could learn at school nearly the whole of the mathematics necessary for an advanced physical course. But to do this would jeopardise his chance of obtaining a first class in the science tripos unless the authorities recognised the value of his mathematical training by a substantial equivalent of marks, so that he might make a mathematical entrance scholarship the preliminary to a science course. For those who have not a taste for theory it would still be possible to adopt an experimental regime from the outset, though it is questionable whether they could in the long run bear comparison with men who had cultivated a faculty which it is no exaggeration to call a sixth sense. The glory of Cambridge and her highest traditions are centred in the names of her mathematical physicists. But the environment which surrounded Maxwell and Kelvin no longer exists. And to-day the growth of subjects and the consequent tendency to specialisation have gone far to materialise the phantom barrier which separates the practical from the theoretical, and have laid on the authorities the burden of creating a new system which shall be capable of reproducing the giants of the past.

Dulwich College, March 13. C. A. Rumsey.

The Morphology of Pleuronectidæ.

In the *Memoir* on the Plaice by Messrs. Cole and Johnstone, reviewed in Nature of March 20 (p. 459), there is a reference to Steenstrup's work on the metamorphosis of Pleuronectidæ which I think the reviewer would have done well to correct. The statement to which I refer is the following:—"This supposition (that the left eye passed through the substance of the head to reach the ocular side), absurd as it may seem to us now, was in fact believed by such an observer as Steenstrup." The truth of the matter is that Steenstrup did not believe any supposition, absurd or otherwise, on the subject, but stated from actual observation that in certain larval Pleuronectidæ the eye of one side passed through the tissues of the head and emerged on the other side. The form in question was long known as Plagusia, and is now known to be the larva of Rhamboidichthys. The truth of Steenstrup's observations was fully confirmed by Alexander Agassiz at Newport, R.I.

On the other hand, in the "Story of Life in the Seas," by Prof. S. J. Hickson, it is stated that in the young of the soles the eye of one side passes through the head to the other side. This is equally incorrect.

Messrs. Cole and Johnstone also state that the Gadidæ are the nearest relatives of the Pleuronectidæ, and promise to show that the morphological differences between the cod and the plaice, apart from the question of symmetry, are comparatively few and unimportant. I cannot find in the *Memoir* that they have redeemed this promise, and the morphological similarity of the two forms is contradicted by the authors themselves on p. 185 of the *Memoir*. I believe it could be shown by proper investigation that the morphological differences between these two fish are numerous and profound.

I think some explanation was due from the reviewer concerning Dr. Woodward's "startling discovery" that in Cretaceous times Teleostei of the Clupeoid type had already translocated the pelvic fin into the jugular position. I have not yet had the pleasure of seeing Dr. Woodward's latest volume, but a Clupeoid with jugular fins seems to me indeed a startling discovery.

Penzance, March 22. J. T. Cunningham.

When writing I was well aware that the sentence Mr. Cunningham quotes was not happily construed, but seeing that comment (like that of Mr. Cunningham himself) would needs be hypercritical, I allowed the matter to pass, in consideration of the context and of the desire to keep my review within bounds.

Concerning the Cretaceous teleostean described by Dr. Smith Woodward, I can only express my surprise that Mr. Cunningham should be so neglectful of the current literature of his subjects as to be unaware of its occurrence. With the rest of his letter I have no concern.

The Writer of the Review.

Sun Pillars.

I have been deeply interested in the correspondence in Nature bearing on the appearance of sun pillars, and particularly so in the communication of Prof. Johnstone Stoney (p. 465).

The display of March 6 mentioned by the Rev. Guy Bridges and Mr. W. A. Knight was not visible here; but a very noteworthy occurrence of the phenomenon took place here on December 3 last and another on January 7 last, and there was one feature common to both of these events which has not been mentioned as occurring in relation to those recorded by other observers, so far as I am aware, but which seems to me to be a prime factor in the causation of the phenomenon under consideration, and it is this:—Before, and after, the actual time of the setting of the sun, during my own observations, there was a strong display of cirrus cloud in the "true cirrus" form of parallel bars, which appeared to run at right angles to the track of the setting sun, and roughly parallel, of course, to the horizon. As the setting sun neared the horizon, these bands of cloud became magnificently iridescent, displaying the spectrum colours of the rainbow, with the red nearest the horizon. As the sun set further the colours faded, beginning first at the red and following on in succession to the violet until this colour alone remained visible. Then ascended a beautiful pillar of a violet colour in exquisite shades, ascending gradually to a height of somewhere about twenty degrees above the horizon and then fading away slowly.

It seemed to me that the occurrence depended on (*a*) the presence of cirrus cloud (ice spiculæ); (*b*) these clouds must be in a banded or striated form; (*c*) they must lie at right angles to the track of the sun; and (*d*) these clouds must, of course, be present in the immediate neighbourhood of the setting sun. There are, besides, certain atmospheric conditions which seem to be desiderated in order to favour opacity, as dryness of the air, with calmness in its movements, and, I believe, a comparatively high barometric pressure. At the time of my observation of December 3, the relative humidity of the air was 75 per cent., the wind calm, and the barometer, corrected to 32° and sea-level, 30·284 inches. On January 7, relative humidity was 76·5 per cent., wind faint; barometer 30·499 inches. The altitude of this station is 480 feet; lat. 54° N., long. 1°.36 W. G. PAUL.

Corporation Observatory, Harrogate, March 24.

THE sun pillar described by your correspondents was very well seen from the railway between Netley (5.40) and Southampton (6 p.m.), and lasted, I think, more than half an hour. It was visible before and after sunset. The upper air at the time was remarkably calm; the morning had been foggy, and the morning of March 7 was also foggy on the ground. Observation of the upper clouds on the morning of the 6th, and at the time of the phenomenon, showed an extremely slow movement from the north-west, barely noticeable between telegraph wires overhead. At 9 a.m. on the 7th cirrus was moving very slowly from about north, and at noon from north-west.

R. RUSSELL.

Condercum, Alum Chine, Bournemouth, March 24.

THE accounts of this rather rare phenomenon (as it seems to be) come (so far) only from the south-west of England. It is, therefore, worth while adding the following as seen at Oxford by myself and friends:—

March 6, 6.18 p.m.—A vertical pillar of flame-coloured light, springing probably from the sun below the horizon, quite parallel-sided, about ⅗° wide and 6° high, careful measurements, perfectly steady for the 10 minutes that we were able to look that way. We thought there was a condensation of light, as of a faint mock sun, about 4° above the horizon. It was fading off downwards appreciably at the last moment.

Littlemore, Oxford. W. J. HERSCHEL.

IF the phenomenon of so-called "sun pillars" can only obtain when the atmosphere is "quite free from convection currents . . . (which it seldom is)" [see NATURE, March 20], is it not reasonable to suspect that the thing seen on March 6 was *not* such an atmospherical phenomenon? since it was viewed east and west from Brighton to the Cornish coast and northwards to High Barnet and Carmarthen Bay, so far as has been already ascertained.

If the barometrical and thermometrical readings, wind velocities and directions over this wide area on the 5th, 6th and 7th inst. could be obtained, an examination of these would go far to settle the question. CATHERINE O. STEVENS.

Bradfield, Berks, March 31.

Sounds Associated with Low Temperatures.

THE whistling or squeaking of snow under foot at low temperatures is a familiar phenomenon to residents in such climates as that of Canada. The sound is in strong contrast to the crunching of snow at the freezing point.

I suspect that "walking about the sheds" in the letter quoted by Sir Wm. Preece (p. 487) means walking over snow-covered ground between the sheds. J. D. EVERETT.

11 Leopold Road, Ealing, March 29.

I HAVE, I think, frequently heard the sounds mentioned in the letter sent to you by Sir William Preece; but if the sounds I mean are the same as those there described they are not necessarily associated with low temperatures, though they would be more likely to be noticed when the ground is frozen. The sounds to which I refer are to be heard near palings or sheds made, as they frequently are, with overlapping boards. The explanation I have always supposed to be as follows:—If the ground is sharply struck, with the boot for instance, the sound thus made will be reflected back by the ends of the boards; as each of these ends is further from the listener than its neighbour, the echoes will come back at intervals depending on the distance of the observer from the paling and on the width of the boards; if the boards are of equal width, the echoes will come back with nearly equal intervals between them, thus producing a musical note. If the ground is frozen, the sharp sounds necessary will be produced when walking by one's boot striking the ground; but the same sounds may be produced in dry weather and especially when walking on gravel. I have often observed the musical note, but never where such an explanation would not be possible. Wooden palings are not, however, necessary; I have heard the same thing when walking past iron palings, more particularly, as is to be expected, when the uprights have a square section. CHARLES J. P. CAVE.

Binsted, Cambridge, March 31.

CENTRAL AND SOUTH AMERICA.[1]

CENTRAL AMERICA and the West Indies are attracting so much attention at present that a comprehensive description of them is of especial value to all who are watching the growth of political power in the New World. Hence we may welcome Mr. Keane's work, which, *inter alia*, treats of their history, physical geography, climate, flora, fauna, ethnology and industries, as well as of their financial and commercial statistics. The volume, although purporting to be a "new issue," might well claim to have no relation to the old one, edited, a quarter of a century ago, by the well-known naturalist H. W. Bates; for the knowledge of the region which has accumulated during the interval has been largely utilised, although not brought up to date in some important respects. Besides ten carefully executed maps, not overloaded and confused by unimportant names, the work contains numerous illustrations.

Mr. Keane opens his subject with a comprehensive chapter on the physical and biographical relations of the countries under consideration. "The present Central American mainland, like the Southern continent, formed, originally, a vast insular region, which was gradually consolidated in Tertiary and later times. It constituted a great archipelago, which stretched, for about 770 miles, in a south-easterly direction from Tehuantepec to Panama, and presented certain analogies to the West Indian insular world, with which it is in fact connected by at least two chains of islets, reefs, and partly or wholly submerged marine banks. . . . It is difficult to realise the fact that the 'American Mediterranean,' as the Gulf of Mexico and Caribbean Sea are often called, has a circuit from Cape Sable round to the Bahamas of no less than 12,000 miles. . . . The volume of water (the Gulf Stream) rejoining the equatorial current north of Florida strait, though relatively small, forms none the less a liquid mass about fifty-five miles wide and 450 fathoms deep moving at the rate of from two to six miles an hour, and is thus equivalent to as many as 300,000 rivers as copious as the Mississippi." It may be remarked that Maury is contented with giving the flow of the Gulf Stream through this strait as 1000 times the volume of the mighty river mentioned.

Mr. Keane discusses at length the ethno-geographical relations of the almost numberless tribes which have made the lands bordering the Gulf of Mexico and Caribbean Sea such an interesting study, and he concedes to the Toltec, Aztec and Maya peoples a high degree of civilisation. Most writers do the same, as they let their imagination revel in the romantic accounts of the conquest of Mexico and the descriptions of the ruins found from New Mexico to Panama; but it may be doubted if any of the tribes of Indians who occupied that region ever reached a higher grade than the "Upper Status of Barbarism" so admirably defined by Lewis H. Morgan in his "Ancient Society."

As to the Carib race, the cradle of which Mr. Keane rightly fixes in the heart of South America, they wandered north to the shores of the Caribbean Sea, to which they gave their name, and which recognised, throughout its

[1] Stanford's "Compendium of Geography and Travel" (new issue). "Central and South America." Vol. ii. Central America and West Indies. By A. H. Keane, F.R.G.S. Edited by Sir Clements Markham, K.C.B., F.R.S. Pp. xxiv+496. (London: E. Stanford.) Price 15*s*.

islands and coast lands, their all-conquering predominance. In fact the Carib, a born navigator, was the connecting link between North and South America, and freely navigated the Gulf of Mexico and the Caribbean Sea for purposes of war or trade.

Commenting on the "pre-Columbian cultered Toltecs of Mexico," the author shows how these were pushed aside or driven southward by the invasion of the Nahuas from the north, who extended their conquests, by the Pacific coast, into Guatemala and Yucatan, and "penetrated beyond this region into Nicaragua, everywhere founding settlements amid the surrounding aborigines." But the Nahuatlacâ (Aztec) race really overran Central America as far south as the Isthmus of Panama. Vasquez de Coronado, in 1564, met a cacique, Iztolin, on the southern shore of Almirante Bay, who conversed with him in the Nahua tongue; and Ferraz has shown that numerous existing geographical names in Costa Rica are of Nahua derivation. But Panama was probably a debatable ground between them and the Indians of Colombia, or between them and the Caribs who occupied and crossed the isthmus and extended their raids to the Pacific coast of Colombia, which was populated by the Chocoamas. These, according to Codazzi, spoke Cueva, a mixture of Carib and Chocoama. That the Panama Indians were in communication with those of Nicaragua (which were, in turn, in contact with those of the Mexican tableland) is also proven by the first Spanish exploring expedition sent northward (1516) from the Pacific side of the isthmus, near which they found a large bay, where the Chinchiris Indians gave the information that there was a communication between the two oceans through a great interior lake (Nicaragua).

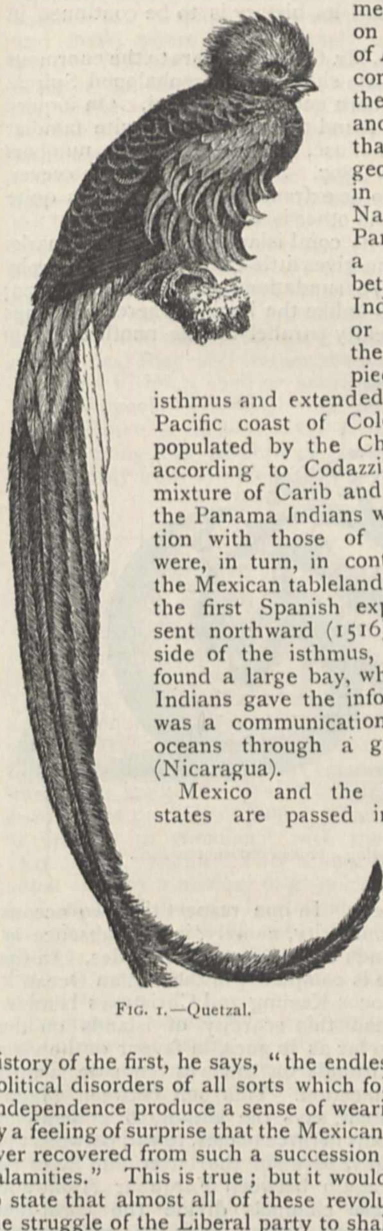


FIG. 1.—Quetzal.

Mexico and the Central American states are passed in review by Mr. Keane, and their history, geography, physical features, &c., receive such attention as is possible within the limits of the volume. Regarding the history of the first, he says, "the endless revolutions and political disorders of all sorts which followed the War of Independence produce a sense of weariness accompanied by a feeling of surprise that the Mexican people could have ever recovered from such a succession of overwhelming calamities." This is true; but it would have been useful to state that almost all of these revolutions represented the struggle of the Liberal party to shake off the baneful grip of the Church, which, in 1827, had 150 convents scattered over Mexico, and, in 1833, held more than one-third of the country in mortmain. Moreover, Europe was responsible for aiding the clergy in the last grand struggle of the latter to retain their power, through the establishment of an Imperial Government under Maximilian, backed by a French army. It was the most terrible and desolating war that Mexico ever saw; but the effort of the Church was a disastrous failure—the greatest of Mexicans, the Indian Juarez, was the victor, and the Constitution of 1857 and the Laws of Reform of 1859 remained triumphant, and became the basis of the subsequent remarkable progress of the country.

Quoting a careless writer, Matias Romero, Mr. Keane gives Mexico 15,000,000 inhabitants and estimates the whites at 19, the aborigines at 38 and the mixed at 43 per cent. of the population; but such statements are only based on personal judgment. I should be inclined to estimate the aborigines at at least one-half of the entire population. It is a question if the aboriginal blood is not stronger than the Spanish, and if it will not, in the long run, aided by climate and environment, *indianise* the latter, unless arrested from the north.

Remarking on the mineral wealth, Mr. Keane gives the total mintage of Mexico since 1537 at 706,000,000*l*. This is probably understated; the eminent statistician Miguel Lerdo Tejada, in 1853, in an elaborate statement, gave the total amount coined, from the conquest up to 1852, at 3,562,204,897 dollars (pesos), of which 110,000,000 dollars remained in the country. The amount exported did not include contraband shipments of uncoined silver, which were enormous.

It is impossible within the reasonable limits of a review to comment upon all the interesting and varied data contained in Mr. Keane's valuable book. Some of the countries, however, of which it treats have already outgrown it; Spanish America, with all its turmoil, moves faster than Europe. In speaking of the two principal Atlantic ports of Mexico, Mr. Keane says that below Tampico, "six miles above the mouth of the Panuco river, this is so shallow that vessels drawing over nine feet have to ride at anchor outside the bar"; and as to Vera Cruz, "there is no harbour at all. . . . Vera Cruz should certainly have been founded at Anton Lizardo, fifteen miles further south, which has the only good harbour in the Gulf." These statements should be modified somewhat; the bar of Tampico has been deepened, and admits ships drawing twenty feet of water. The total net register tonnage of vessels entering the port now exceeds that of Vera Cruz. The fine port works of the latter (enclosing an area of nearly a square mile) give safety for ships of heavy draught. As to Anton Lizardo, as a harbour, its safety against "northers" could only be assured by building a very long breakwater on the reef which partially protects it and which is only visible at low water.

Reaching the Central American States, the author properly describes Guatemala as "almost an Indian republic." Here the population double their chances for the efficacy of prayer by worshipping at a Christian altar with images of their heathen deities hidden behind it. The physical features of the country, its products, character of its people and their Government are similar to those of the densely populated contiguous state of Salvador. Honduras, which has been the victim of financial depredations from abroad rivalling in magnitude its almost unequalled natural resources, is well and vividly outlined. It is the richest in mineral wealth of all the Central American States. Nicaragua and Costa Rica are treated at some length. The former is distinguished by three physical zones:—"(1) the Mosquito seaboard, partly of coralline (marine), partly of alluvial formation; (2) the uplands of the interior, with the Cordillera de los Andes forming part of the original continental framework, and extending from Mosquitia to the great depression which is now flooded by lakes Nicaragua and Managua; (3 the coastlands between the lakes and the Pacific, which are mainly of igneous origin and form a southern continuation of the Salvador volcanic system. . . . Thanks to a mean altitude of from 2000 to 3000 feet above the sea, the central uplands, including the Atlantic slopes of the Nicaraguan backbone, enjoy a relatively mild climate, generally healthy and suited for European settlement." Of Costa Rica, "probably 275,000, out of a total population of 294,000, have already been fused in a somewhat homogeneous Ladino element of Spanish speech and culture. As in Salvador and Nicaragua, the people are concentrated in the fertile and salubrious volcanic districts on the Pacific slope." Mr. Keane's description of the principal West Indian islands is admirable and varied, and enables the reader to understand their importance in the general movement of the world; but the voluminous publications of the United States Government, in 1900, relative to Cuba and Puertorico, might have been consulted with advantage. Saving the defect that much of the industrial, financial and commercial data are not brought up to date, the volume is an extremely useful and instructive compendium of the subjects of which it treats, and does great credit both to the publisher and the author. One of the illustrations is reproduced on the preceding page. George Earl Church.

THE MALDIVE AND LACCADIVE ARCHIPELAGOES.[1]

FEW oceanic island groups are of greater interest to the students of the science of "distribution" than the Laccadives, Maldives, Chagos and Seychelles, since they appear to be the last remnants of a land connection between India and Madagascar. For instance, Dr. W. T. Blanford, in his presidential address to the Geological Society for 1890, after mentioning that there appeared to be evidence of deep water between the banks on which the abovementioned islands are situated, proceeded to say that he believed a fuller knowledge of the contours would reveal the existence of a bank connecting the whole series from India to Madagascar. "Even should this not be case, the evidence of a land-connection appears so strong that it may be a question whether the whole of the ocean-bottom between Africa and India may not have sunk to its present depth since Cretaceous times."

In addition to this special point of interest, the coral-reefs of the Maldives, Laccadives and Ceylon have an interest of their own in regard to their mode of formation and growth, the fauna by which they are inhabited, and the evidence they afford either of upheaval or of subsidence in this part of the Indian Ocean. The managers of the Balfour studentship, with the assistance of donations from the Government Grant Committee of the Royal Society and the British Association, were therefore well advised in selecting this area as one where a careful and detailed geographical and zoological survey would be likely to yield results of the highest scientific importance. So far as can be judged from the small section of the work now before us, Mr. Gardiner, ably seconded by Messrs. Borradaile and Cooper, appears to have carried out his task with great thoroughness and success. A part of the time, it is true, he was incapacitated from work by illness, but during his absence the researches were carried on with vigour by Mr. Cooper, who took no less than eighty-eight dredgings in five different atolls.

[1] "The Fauna and Geography of the Maldive and Laccadive Archipelagoes, being the account of the work carried on and of the collections made by an expedition during the years 1899 and 1900." Edited by J. S. Gardiner. Vol. i., part i. (Cambridge: University Press, 1901.)

Until the appearance of the complete work, which we gather will run to at least two volumes, we cannot, of course, lay before our readers the editor's conclusions with regard to the important problem mentioned at the commencement of this article. Neither can we refer to the general *facies* of the fauna of these islands. Our notice must accordingly be restricted to the general introduction to the work and the four chapters which (together with a description of certain sections of the fauna) constitute the part before us.

For reasons connected with the meteorological conditions prevailing in the Indian Ocean, it was decided to devote the summer of 1899 to a thorough survey of Minikoi, the most southern atoll of the Laccadives. This island forms the subject of two out of the four chapters already published, and its history is to be continued in those which follow.

In the introduction, Mr. Gardiner refers to the enormous numbers of the delicate shells of the cephalopod Spirula met with on the northern end of one island. On inquiry from the natives he found that they were quite familiar with the complete mollusc, which appeared in numbers during the winter of 1897. Strangely enough, however, the creature seems to be extremely local, since it is quite unknown to any of the other islanders.

In the chapter on its coral islands, the author remarks that the Indian Ocean gives little clue from its topography to the character of the foundations of the various groups; and in this respect is unlike the Pacific, where the groups run more or less nearly parallel to one another and to

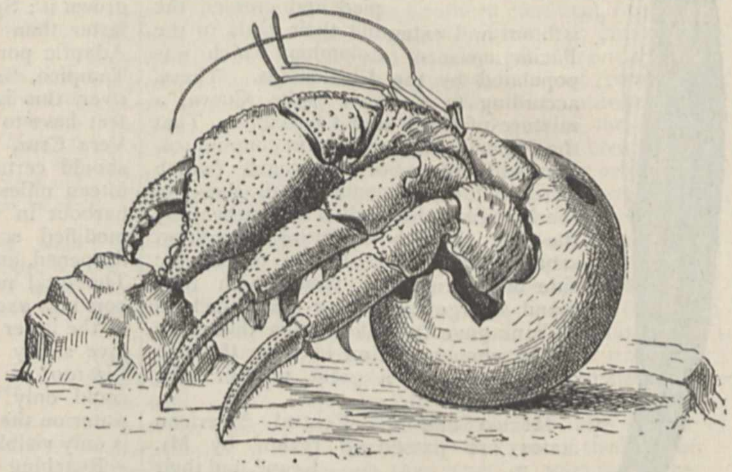


Fig. 1.—*Coenobita clypeatus* using a broken cocoanut as shell.

the adjacent continent. In one respect the two oceans present a striking similarity, namely, in the absence or paucity of coral-islands on their eastern[1] sides. In the Pacific this absence is complete; in the Indian Ocean it is broken only by Cocos-Keeling and Christmas Islands. In the Indian Ocean this scarcity of islands on the eastern border is, so far as it goes, in favour of the view that the numerous islands on the western side formed part of a land-connection. This belt between Madagascar and India is cut, says the author, to a depth of more than 2000 fathoms in three places, to wit, between the Maldives and Chagos, between the latter and Saya de Malha Bank, and again between Farquhar Atoll and Madagascar. "These channels divide the coral-reef areas into four sections, which may be respectively termed the Malagasy, Seychelles, Chagos and Maldive." These four sections are then discussed in detail.

Chapters iii. and iv. are devoted to part of the descrip-

[1] The author writes "western," but he obviously means "eastern."

tion of Minikoi, of which a map is given. Although at one point the land is gaining on the lagoon, in others it is gradually diminishing, and the author prophesies that in course of time the sea will make a clean sweep of some parts of the atoll.

Much attention is devoted to the mode of formation of a coral conglomerate found in Minikoi and elsewhere at the base of the outer beach. From the presence of this conglomerate and other evidence, the author concludes that an elevation of at least 24 feet must be admitted to have taken place in Minikoi, and this during the time that it has existed as an atoll. "The presence of conglomerate masses," he adds, "I can only regard as indicating the existence of former land in any position where they now occur. The land there must have at one time extended round the whole island with only a single break, perhaps to the north, with lower parts here and there, where boat-channels across the reef now exist." Minikoi was indeed once apparently very like some of the low coral-islands of the Maldive group in the Indian Ocean and the Ellice group in the Pacific. For the final chapters on Minikoi we must await another fasciculus of the work.

The groups of the Minikoi fauna included in this fasciculus comprise the Hymenoptera, by Mr. P. Cameron; the land crustaceans, by Mr. L. A. Borradaile; and the nemertean worms, by Mr. R. C. Punnett. Among the second of these perhaps the most generally interesting group are the land hermit-crabs of the genus Cœnobita. Like the great cocoanut crab (*Birgus latro*), these crabs have forsaken the sea for a life on land, although (unlike the former) they still retain the habit of sheltering the abdomen within a shell or some such covering. In the case of a specimen of which the figure is here reproduced, the abdomen is encased in the broken shell of a cocoanut. Among the nemertean worms, a genus hitherto known only from Amboina has been met with again at Minikoi.

R. L.

PROF. MAXWELL SIMPSON, F.R.S.

MAXWELL SIMPSON, ninth and youngest child of the late Thomas Simpson, was born at Beech Hill, co. Armagh, Ireland, on March 15, 1815. Educated at a private school in Newry, he thence proceeded to Trinity College, Dublin, where he took his Arts degree, and subsequently entered the School of Medicine. In 1847 he graduated as Bachelor of Medicine in Trinity College; but already he had been strongly attracted towards the study of chemistry, and instead of settling down to the practice of physic, he now became associated, as lecturer in chemistry, with the medical school of Park Street, Dublin. This school had been established about 1824 by a number of physicians and surgeons, and had included among its teachers James Apjohn, subsequently professor of chemistry in the University of Dublin. From Park Street he was transferred to the Peter Street School of Medicine, where he remained for a few years.

Inspired, however, by a profound love for science, the limitations incidental to such a post grew irksome to him; the desire to secure adequate outlet for his intellectual energies, to prosecute his own inquiries, and to enjoy the communion of fellow-workers intensified with time, until finally, casting aside all material considerations, he relinquished his teaching and proceeded to the Continent, where, associated with some of the most eminent chemists of the day, he was free to breathe the congenial atmosphere of research.

Plunging with characteristic energy and enthusiasm into work, he soon became productive. In 1851 he studied with Kolbe at Marburg, then under Bunsen at Heidelberg, conducting in the laboratory of the latter an investigation on which his first original paper was based; this communication, "On two new Methods for the Determination of Nitrogen in Organic and Inorganic Compounds," published in the *Journal* of the Chemical Society (vi. 289) and in the *Annalen der Chemie und Pharmacie* (xcv. 63), foreshadowed the accuracy and thoroughness which were to mark his later work.

Moving next to Paris, and entering the laboratory of Wurtz, his attention naturally became centred on organic chemistry, and here his capacity for work was quickly manifested; commencing with a paper on the "Action du Brome sur l'Iodure d'Aldéhydène," read before the Académie des Sciences on March 1, 1858, one memoir followed another in rapid succession. In April he made a communication "Sur une Base nouvelle obtenue par l'action de l'Ammoniaque sur le Tribromure d'Allyle," another on the same subject in August, and a third in November on the "Action du Chlorure d'Acétyle sur l'Aldéhyde"; these he followed up by two papers (*Proc.* Roy. Soc., ix. 725 and x. 114) "On the Action of Acids on Glycol." On April 25, 1861, Prof. Frankland communicated, on his behalf, to the Royal Society the first of two important papers "On the Synthesis of Succinic and Pyrotartaric Acids," in which he showed that the former, built up from ethylene, through the dibromide and corresponding cyanide, is identical with common succinic acid; the latter, from propylene bromide, with the pyrotartaric acid got by distilling natural tartaric acid—thereby establishing the chemical constitution of both. This excellent piece of work met with due recognition, and in 1862 Maxwell Simpson was admitted a Fellow of the Royal Society.

Two other communications appeared (*Proc.* Roy. Soc., xi. 590 and xii. 278) "On the Action of Chloride of Iodine on Iodide of Ethylene and Propylene Gas," and, almost concurrently with these, two more, now classical, "On the Synthesis of Tribasic Acids" (*ibid.* xii. 236, and *Journ.* Chem. Soc., 2, iii. 331); here it was shown that from allyl tribromide, a corresponding tricyanide can be obtained, which by saponification yields a salt of tricarballylic acid—this substance is an immediate derivative of glycerine, and "bears the same relation to citric acid that succinic bears to malic acid."

It is not possible within these limits of space adequately to notice Simpson's work or its bearing. Of his further papers may be mentioned: "On the Acids that may be derived from the Cyanides of the Oxy-radicals of the Di- and Tri-atomic Alcohols"; "On the direct Transformation of Iodide of Allyle into Iodide of Propyle"; "On the Action of Chloride of Iodine upon Organic Substances"; "On the Formation of Di-iodacetone"; "On the Formation of Succinic Acid from the Chloride of Ethylidene"; "On a new Compound formed by the direct union of Aldehyde and Anhydrous Prussic Acid" (with Dr. Gautier); "On the direct Transformation of Chlor-iodide of Ethylene into Glycol"; "On some new Derivatives of Acetone"; "On the Brom-iodides"; "On the Determination of Urea by means of Hypobromite of Soda" (with Mr. C. O'Keeffe), and a paper (*Proc.* Roy. Soc., xxvii. 120) "On compounds of Silver Iodide with Alkyl Iodides." Of the above work, that described in the paper on aldehydes and hydrocyanic acid is especially important, leading, as it did, to the synthetical production of one of the forms of lactic acid.

In 1872, Maxwell Simpson was appointed to the chair of chemistry in Queen's College, Cork, an office which he resigned after nineteen years of service.

His power was by no means confined to the research laboratory; as a lecturer he possessed in a high degree that gift of luminous exposition which is the product of quick and accurate memory, clear intelligence and ready command of language. Simple and unaffected, genial of manner, though strong in the courage of his convictions; direct and original in thought and speech, Simpson's personality was forceful, interesting and lovable. Endowed as he was, it may seem strange that he did not establish a school of chemistry in Cork. But the reason is not to be found in the man—rather in his surroundings. Placed, as he was, in a sparsely populated district, where poverty is, unhappily, the rule, where chemical manufactures are but few, and where the demand for highly trained chemical knowledge of any sort is practically non-existent, the result flowed almost inevitably from the conditions.

At various times he acted as examiner in chemistry to the Civil Service of India, the Civil Engineering College, Coopers Hill, and the Royal Military Academy, Woolwich; he was an Honorary Fellow of the King's and Queen's College of Physicians; received the degrees of M.D. and LL.D. (both *honoris causa*) from the University of Dublin; was a senator of the Queen's University; Fellow of, and examiner in, the Royal University of Ireland, from which he received the degree of D.Sc. (*honoris causa*); he was also selected as president of the section of chemistry of the British Association at its meeting in Dublin in 1878. In addition, he was for several years a member of the council of the Chemical Society, by which he was elected, during the years 1872–74, to the office of vice-president.

On February 26, Maxwell Simpson passed away in London; his work remains, a worthy and enduring memorial to his love for that science which he so generously enriched. A. E. Dixon.

NOTES.

Prof. E. C. Pickering announces that he has received from a friend a gift of twenty thousand dollars (4000*l.*) for the benefit of the Harvard College Observatory. It is proposed to expend about one-half of this fund in extending the present building in which the astronomical photographs are kept, so as to provide for the adequate storing of this collection with its probable increase for many years. These photographs furnish a history of the entire stellar universe for the last twelve years, and is not duplicated elsewhere. A portion of the remainder of the gift will be used at once to provide for the study of objects of interest on the photographs, as hitherto only those of special importance have been examined.

The Raoult Memorial Lecture of the Chemical Society was delivered by Prof. van 't Hoff on Wednesday of last week. Shortly after Raoult's death, a year ago, a short account of his career was given in these columns (vol. lxiv. p. 17). Prof. van 't Hoff remarked that the scientific work could be conveniently considered as belonging to three periods of Raoult's life—physical, chemical and physiological. As a typical research of the first period he mentioned the study of the heat evolved by chemical reactions in the voltaic cell and that due to the electric current. Later, Raoult directed his attention to subjects of a more purely chemical nature, such as the influence of solar radiation on the inversion of cane sugar, and the absorption of ammonia by saline solutions. His physiological work included studies of the presence of copper and zinc in the animal organism and the influence of carbon anhydride on respiration. But Prof. van 't Hoff pointed out that the researches which made Raoult's name famous as a scientific investigator were those which led to the establishment of a definite connection between the lowering of the freezing points and of the vapour pressures of solvents by the presence of dissolved substances. This led Prof. van 't Hoff to the important generalisation that the osmotic pressure of a dissolved substance bears a definite relationship to the pressure it would exert if it were in a state of vapour—a theory which has been of immense service in elucidating the nature of solutions and has also led to the theory now widely accepted as to the existence in dilute salt solutions of the ions of the dissolved substance.

We regret to see the announcement of the death on Good Friday of Mr. G. F. Wilson, F.R.S., whose scientific work included the discovery of the means of obtaining pure glycerine, and numerous papers on horticultural subjects. Mr. Wilson was in his eightieth year.

Lord Kelvin is expected to arrive in New York on April 19. *Science* states that a reception will be given in his honour on the evening of April 21 by Columbia University, the American Institute of Electrical Engineers, the New York Academy of Sciences and other scientific societies.

On Tuesday next, April 8, Dr. Allan Macfadyen will deliver the first of a course of three lectures at the Royal Institution on "Biological Inquiry"; on Thursday, April 10, Prof. Dewar will begin a course of three lectures on "The Oxygen Group of Elements." The Friday evening discourse on April 11 will be delivered by Prof. Dewar on "Problems of the Atmosphere," and on April 18 by Sir John H. A. Macdonald, his subject being "The Autocar."

The Berlin correspondent of the *Times* states, upon the authority of the *Lokalanzeiger*, that a scheme is under consideration by the German Imperial authorities in accordance with which the chief commercial nations, especially England, France and the United States, will be invited to send representatives to an international congress, the object of which will be to arrive at an agreement forbidding the establishment of any monopoly in wireless telegraphy on the high seas. This step, it is stated, is the direct consequence of the refusal of the Marconi station on the Nantucket lightship to enter into communication with the *Deutschland* during its homeward journey with Prince Henry of Prussia on board.

We learn from the *Times* that the University of Chicago has commissioned Mr. Alleyne Ireland to report on the financial, commercial and social conditions of all the European colonies in the Far East, where the circumstances appear both geographically and historically to bear some resemblance to the general situation of the Philippines. Mr. Ireland will visit Burma, Siam, the Federated Malay States, the Straits Settlements, Sumatra, Java, British North Borneo, Sarawak, French Indo-China, Tonking, Formosa and Hongkong. After making an investigation of the general condition of the Indo-Malayan people under British, Dutch, French, and native rule, he will then go to the Philippines in order to examine the conditions of those islands from the comparative point of view. It is anticipated that his inquiry will occupy about two years.

At the request of the U.S. Senate, the Secretary of Agriculture has reported upon the condition of the American bison. In his summary he states that this species is on the verge of extermination. Scarcely a handful now remain of the millions which formerly roamed over the plains of the west. Only two small herds of wild buffalo are in existence in the United States—one in the Yellowstone Park, the other in Lost Park, Colo. There are no wild buffalo in Canada, except in the Peace river country, where a few woodland buffalo, believed to be a different species from the American plains buffalo, still exist. A number of buffalo have been domesticated and half-domesticated, there being three important herds in addition to the small herds in zoological parks and in the hands of private individuals. It is suggested that if the Government would acquire possession of a considerable number of full-blooded animals the absolute extermination of the species might be long delayed.

THE fourteenth International Medical Congress will be held at Madrid on April 23-30 of next year. The *British Medical Journal* states that in almost all the countries of Europe and America local organising committees have been formed. The Spanish Minister for Foreign Affairs has invited all Governments to send representatives. A similar invitation has been sent to all universities and medical schools, and to the principal medical societies in all countries. Among the numerous applications for membership which have up to the present been sent in are the names of eighty-five delegates, and there is every prospect of a most successful meeting. Among the notabilities of the medical world who have promised to deliver addresses are Profs. Pavlov, Maragliano, Thomson, Laache, Waldeyer, Cajal and others. Almost all the various sections have arranged their programmes of discussions, and they are now grappling with the task of selecting men to open them. A preliminary programme, including not only the official list of discussions, but the titles of communications offered, will shortly be issued.

As already announced, the jubilee of the scientific career of the eminent palæontologist, Prof. A. Gaudry, was celebrated at Paris on March 9, when many of his old pupils, friends and

admirers assembled to do him honour and to offer him a medal commemorative of his services to science. Delegates were present from numerous learned societies and academies, including our own Royal Society; and addresses were delivered by M. E. Perrier, director of the Natural History Museum, where the celebration was held, M. M. Boule and M. Liard. The accompanying illustrations from *La Nature* show the medal which was presented to Prof. Gaudry as a slight mark of appreciation of his work in palæontology and the honour it has brought to France and to the museum with which he has been so long connected as student, assistant naturalist and professor.

THE Russian Geographical Society has sustained another heavy loss by the death of General Mikhail Vasilievich Pyevtsoff. He was born in 1843, received his education in a military school, and next in the Academy of the General Staff, and after having finished his studies remained for fifteen years at the General Staff at Omsk, making important journeys in Dzungaria and north-western Mongolia. He also took part in the great surveys which were made in 1880 on Chinese territory in connection with the tracing of the boundary between China and Russia. The results of the first two journeys were embodied in papers published in the *Memoirs* of the West Siberian Geographical Society, the description of north-western Mongolia, by Pyevtsoff, being the best work on the subject. In 1888, after the sudden death of Prjevalsky, Pyevtsoff was nominated head of the Tibet expedition, and, in company with Roborovsky and Kozloff and the geologist Bogdanovich, he explored during two years eastern Turkestan and the Gobi—the results of these explorations being now embodied in three quarto volumes edited by the Russian Geographical Society. Pyevtsoff also contributed to theoretical geodesy an important paper on the determination of latitudes from the corresponding altitudes of two stars—a most useful extension of M. Tsinger's method, which has been largely applied since by Russian explorers in Central Asia—and another on barometrical levellings.

THE series of Saturday afternoon excursions of the London Geological Field Class, conducted by Prof. H. G. Seeley, F.R.S., will commence on April 26, when a visit will be paid to Erith. The excursions will be continued on each succeeding Saturday (except on Saturdays before Whitsuntide and in Coronation week) until July 12. Further particulars can be obtained from the hon. general secretary, Mr. R. Herbert Bentley, 43 Gloucester Road, Brownswood Park, N.

DR. H. R. MILL has collected observations relating to the frost of February last from all available sources, and has published in Symons's *Meteorological Magazine* for March an interesting summary of the results, with a sketch-map which shows diagrammatically the number of days of frost in different parts o the country. With the exception of the long-continued cold of

February 1895, the recent frost was the most prolonged and severe that has been experienced in February for half a century. Dr. Mill measures the duration of the frost by the number of nights during which the temperature in the shade fell below the freezing point. In most places the cold weather set in on the 1st, and, generally speaking, lasted for three weeks, except on the sea coasts. For instance, at Torquay the period was nine days, at Eastbourne and some other places twelve days only, while in Suffolk, Yorkshire and Peebleshire the frost lasted for twenty-four days. The lowest shade temperatures were -2° at Lairg (Sutherland) and 0° at Braemar on the 14th. At Camden Square the minimum was $15^\circ \cdot 8$, the only lower records there in February being $15^\circ \cdot 4$ in 1865 and $7^\circ \cdot 3$ in 1895. The mean temperature of the month appears to have been from 3° to 5° below the average in all parts of our islands. Heavy snowfalls occurred in the north and west, but in the south-east there was an almost entire absence of precipitation during the period of the frost.

THE *Scientific American* for March 8 describes and illustrates a very novel form of flying machine which has been devised by M. Henri Villard, of Paris. The machine has not yet been ried, so at present nothing can be said about its capabilities, but the inventor hopes to carry out the first trials next spring. An idea of the apparatus may be perhaps best explained by imagining a rather flat umbrella of considerable size made rigid by an exterior steel rim and wire spokes. On the stick portion of this large umbrella, and under the umbrella, are two pro-ecting arms, one carrying a screw to move the apparatus in a horizontal direction, the other a rudder for steering purposes. Still lower down on this stick, on one side of it, say near the handle of the umbrella, is the motor, and opposite it the seat for the operator. The motor has two functions, one of which is to drive the screw for obtaining the horizontal motion, and the other, which is the novel part of this form of flying machine, for rotating at a rapid speed the umbrella portion. The idea is that the rapidly rotating umbrella with the comparatively heavy rim will act like the wheel of a gyroscope, and that this will tend to keep the machine from being easily moved out of the plane of rotation. The umbrella portion, which is practically a parachute, is a large flat wheel of twenty-two feet external diameter, resembling somewhat a bicycle wheel, the rim of which is made of half-inch diameter circular steel tubing, and this is covered on its upper portion with stout cotton balloon canvas. The parachute or wheel portion is not really a true wheel, but built on the plan of a helix, so that by rapid rotation the whole apparatus can be lifted vertically; it is stated that this will absorb about four horse-power.

AN ingenious and very convenient method for finding the velocity of underground water is described by Prof. Slichter in the *Engineering News*. The method is an electrical one, and consists in determining the time taken for an electrolyte to travel along a certain length of the stream. A double row of $1\frac{1}{4}$ inch drive wells is sunk across the channel of the stream and the upstream wells are charged with a solution of an electrolyte, ammonium chloride having been found very suitable. The electrolyte flows down stream with the moving water, and its arrival at the second row of drive wells is indicated electrically. The best method of connecting up the electrical indicator is said to be the following. One pole of the battery is connected to the outer sheathing of the lower well tubes through an ammeter; the other pole is connected to the upstream tubes and also to an insulated electrode passing down the centre of the downstream tubes. A gradual rise in current marks the passage of the electrolyte down stream; when it arrives at the lower row of wells, the resistance of the circuit between the sheathing and the inner electrode is so much diminished that a sudden kick of the ammeter occurs, marking with great precision the time of arrival. The second circuit may be dispensed with, but the moment of arrival is not in that case so sharply marked. A number of preliminary tests have been made on the rate of movement of the underflow of the Arkansas River, and a more extended and systematic survey is now being undertaken.

IN a paper recently contributed to the Royal Dublin Society, Prof. Johnson, of the Royal College of Science, directs attention to the great injury done by "smut" (*Ustilago avenae*, Jens.) to the oat crop in Ireland, and as the result of two years' experience strongly recommends the use of an American fungicide, "Sar." Sar—so-called because of the ingredients, sulphur, alkali and resin, used in its preparation—consists chiefly of sodium sulphide, and to this compound the fungicidal properties are due. Sar can be made at a cost of *6d.* to *9d.* per pint; and one pint in 30 to 40 gallons of water will cleanse 4 bushels of seed. The grain must be soaked for 24 hours, and for ordinary farm use it would be necessary to provide a tank capable of dealing with one day's supply of seed, say 30 to 50 bushels. Smut is a widespread pest in Britain, but partly because in normal seasons it does not do serious damage, and partly because of the unsuitability of the farmer's ordinary "steep" (solution of copper sulphate) and the trouble attending the use of Jensen's "hot-water" method, few attempts have hitherto been made to deal with the fungus. Prof. Johnson's paper should secure an extended trial for sar in Wales, the west of Scotland, and other moist districts where *Ustilago avenae* is common.

FOLLOWING the example set more than a decade ago by the Government of New South Wales, the Agricultural Department of the Government of Victoria has begun the issue of a monthly journal. In the first part, dated January 1902, the scope of this publication is indicated in an introduction written by the Hon. John Morrissey, M.L.A., Minister for Agriculture. The chief function is to bring the officers of the Department into closer touch with the agricultural population. A considerable body of information is accumulated by the experts employed by Government, and it is felt that unless this information is in active circulation it will prove of little value. An annual report does not meet the farmer's requirements, for "the annual must ever be largely a review, which in daily practice is not so much wanted as the forecast, and this the journal will aim to furnish." The thirty or so articles and notes contributed to the first number by the officers of the Department are direct, practical, freely illustrated, and well calculated to assist the agriculturist. They deal with such subjects as uses of demonstration plots, registration of remounts, best types of vat for wine-making, cream-testing, and inspection of exported butter. The journal is under the editorship of Mr. H. W. Potts. It is well arranged and well printed. It promises to be of much value to the colony.

THE British Mycological Society has just issued its transactions relating to the week's fungus foray held at Exeter in September of last year, and the papers read at the evening meetings. The most successful find was *Femsjonia luteoalba*, a genus belonging to the Tremellineæ, and one up to that time unrecorded for Britain. It was found growing on oak and birch. A paper was read by Mr. B. T. P. Baker, of Cambridge, giving some results of his cultures with Saccharomyces, which were undertaken to determine the conditions regulating spore formation. The cultures were made on plaster of Paris blocks treated with various solutions. The results seem to confirm the views put forward by Heinsen that aëration is the most important condition which regulates the production of spores. The amount of food present is also another determining factor and one which reacts differently with the two species, *S. cerevisieae* and *anomalus*, with which Mr. Baker experimented.

S. cerevisieae forms spores when it is starved, but *S. anomalus*, contrary to the generally accepted ideas, gives a bigger spore yield as the amount of food is increased. Botanists who wish to obtain spores for class work or otherwise will also do well to note that cells of the yeast will only give a good supply of spores when they are about twenty-four hours old, and none at all when they are two days old or more.

PROF. MARSHALL WARD, F.R.S., has summarised for the British Mycological Society a few of the important results which he has obtained in the course of his studies on the susceptibility of different species of brome-grasses to the attacks of the rust fungus (*Puccinia dispersa*). The development of the fungus from the uredospore when taken from one species of Bromus and transferred to another species is found to differ according to the relationship of the two Bromes. If these are closely related, the fungus infects and grows rapidly, whereas a more remote species may be entirely immune from infection. By means of carefully devised apparatus, Prof. Ward has raised pure cultures of grass from sterilised seed in germ-free tubes, and has thus been able to demonstrate that seeds from infected plants are entirely free from disease, thereby proving fairly conclusively the impossibility of intra-seminal sources of infection.

A "CATALOGUE of Altitudes in Asiatic Russia and some adjacent Portions of Asia, on the Basis of Materials Published up to 1894," by Dr. K. Hikisch, appears in the *Memoirs* of the Russian Geographical Society (General Geography, vol. xxxi., 2). The catalogue contains a very valuable list of 11,629 determinations of altitudes in Asiatic Russia, as also in Russian and Chinese Turkestan, Mongolia and Manchuria, published in the same form as they were issued by the respective authors. Unfortunately there remains still an uncertainty of about 100 feet in the altitudes of the fundamental points for most determinations—Irkutsk in Siberia and Tashkend in Turkestan. An alphabetical index of all the names considerably facilitates reference to this catalogue.

MR. JOHN CADMAN has prepared a useful account of the occurrence, mode of working and treatment of the ironstones found in the North Staffordshire Coal-field (*Trans.* Inst. Mining Engineers for 1901). The blackband ironstones occur in the upper portion of the Coal-measures beneath the Etruria Marls; they overlie seams of coal, and the thickness of the coal frequently varies in inverse ratio to the thickness of the ironstone. Sometimes the ironstones assume the nature of cannel coal, and occasionally they pass into limestone. Many fossils have been found in the ironstones, and notably through the researches of Mr. John Ward, but the mollusc Anthracomya is the prevailing shell.

THE geology of the "Riukiu Curve," or of that series of islands which lies between Formosa and Kyūshū in Japan, has been dealt with by Prof. S. Yoshiwara (*Journ.* Coll. Science, Tokyo, Japan, vol. xvi. 1901). The principal rocks of the islands are of Palæozoic age, and comprise slate, sandstone, quartzite and limestone, with amphibolite and schalstein. The ancient sedimentary rocks dip steeply to the west, and are penetrated in places by masses of granite and diorite. They form a median zone in the series of islands. The inner zone in the curve is formed mainly by volcanic rocks, and the outer zone by Tertiary strata of Miocene and later stages, which contain coal-seams and are here and there rather irregularly inclined. Raised coral-reefs are found in various districts, and these are quite horizontal. The maximum elevation of the reefs is 684 feet; they exhibit a character like those now growing in adjacent seas, and they have been upheaved after a gradual depression. The formation of the curve has been explained by Prof. Kotô as due to the depression of the "East Sea" of China, which took place for the most part in the Tertiary period. The volcanic rocks appear to belong to somewhat different stages in that period and to have originated along a great fissure which is continued in the volcanoes of Kyūshū.

THE Royal Zoological Society of Ireland has published a short account of its origin and early history. The author, Dr. D. J. Cunningham, has to lament the absence of documentary evidence, or the extreme incompleteness of such evidence, as to much of the early history of the Society; but in spite of this he has managed to bring together a number of interesting facts in connection with its foundation, and also gives portraits of some of the most prominent among the founders. The Society was established in May, 1830, at a meeting presided over by the Duke of Leinster, Dr. Whitley Stokes being elected the first hon. secretary at the second meeting, held later in the same month. It is interesting to note that the eminent ornithologist Mr. N. A. Vigors, who three years later became the first hon. secretary of the London Zoological Society, took a prominent part in the organisation of the Dublin institution.

OF the five articles included in part iv. of vol. xxix. of Gegenbaur's *Morphologisches Jahrbuch*, four are devoted to mammalian anatomy. In the longest, Herr G. Ruge discusses the varieties of form displayed by the liver of the Primates. The author considers that the mammalian liver was always divided into lobes, and was never, as has been suggested, a simple organ. Some emendation is made in the nomenclature of the lobes, and the homology of the aberrant "spigelian" and "caudal" lobes worked out. In another article, Dr. E. Stromer considers the morphological importance of the foramen found at the lower end of the humerus of many mammals and likewise of the third trochanter of the femur. From its occurrence in so many of the lower types, the entepicondylar foramen, as it is called, is regarded as a primitive structure, of which the original object was to protect certain nerves and blood-vessels. It is remarkable that it should persist in the spectacled bear of the Andes, although it has disappeared in all other living members of the group. The third trochanter of the femur, on the other hand, can scarcely be regarded as primitive, seeing that it is wanting in several of the lower groups of mammals. Neither can its presence be attributed, as Gaudry suggests, to the reduction in the number of the toes, as otherwise it should not be found in the rhinoceros. Its general absence in man forbids the idea of its having any connection with the upright posture.

THE important position occupied by the science of bacteriology in the United States may be gathered from the existence of an American Society of Bacteriologists, which has already held no less than three annual meetings. The last meeting of the society's members was held at the end of last and beginning of this year in Chicago, and a recent number of *Science* contains abstracts of the papers read. A great variety of subjects was dealt with, amongst which dairy bacteriology is well represented by contributions from Mr. H. L. Russell amongst other well-known authorities in this branch of applied bacteriology. A useful paper, as emphasising the results obtained by other investigators in the same field, is contributed by Mr. Caleb A. Fuller on "Oysters and Sewage in Narragansett Bay." The author found that oysters from a bed two miles below the sewer outlet contained bacteria typical of sewage, that 30 per cent. of the oysters from a bed situated in a strong tidal current about five miles from the sewer contained *B. coli*, that 40 per cent. of the oysters from a bed in sluggish water five-and-a-quarter miles from the sewer contained *B. coli*, and that these objectionable bacilli were only absent from oysters in beds situated more than six miles from the sewer outfall. Dr. W. J. Class submits another claimant to the title of the scarlatina microbe, in the shape of a diplococcus said to be invariably present in cases of scarlatina and found in the throat secretions, blood, scales and urine of persons suffering from scarlet fever. He has spent much labour and time in endeavouring to place the title of this *Diplococcus scarlatinae* beyond dispute. The papers submitted, judging by the abstracts supplied by Prof. Conn, were of a high order, and the existence of such a society suggests that bacteriology in this country might well be accorded a more important place amongst the sciences than it at present occupies.

THE ninth edition of Mr. Bennett H. Brough's deservedly successful "Treatise on Mine-Surveying" has been published by Messrs. C. Griffin and Co. The book has been carefully revised, and new devices and appliances of importance are described. "The chief additions," we read, "consist of notices of the use of a spring balance for maintaining steel bands at a constant tension, of Mr. Langer's method of surveying with the hanging compass in the presence of iron, of Mr. Troye's method of marking underground stations, and of Mr. Landis's method of determining the volume excavated in open workings." By keeping his book up to date in this way, Mr. Brough makes his manual most valuable to mining students and mine-agents, who regard it as an essential volume for their libraries.

THE additions to the Zoological Society's Gardens during the past week include a Brown-headed Stork-billed Kingfisher (*Pelargopsis gurial*), an Eastern Calandra Lark (*Melanocorypha bimaculata*), an Eastern Linnet (*Acanthis fringillirostris*), a Glossy Calornis (*Calornis chalybeius*), a Small-billed Mountain Thrush (*Oreocincla dauma*), a Large Pied Wagtail (*Motacilla maderaspatensis*), an Ashy Wood Swallow (*Artamus fuscus*), a Bay-backed Shrike (*Lanius vittatus*), an Indian Great Reed Warbler (*Acrocephalus stentoreus*) from British India, a Pale Rose-finch (*Rhodospiza obsoleta*) from Afghanistan, presented by Mr. E. W. Harper; three Changeable Lizards (*Calotes versicolor*) from India, presented by Mr. R. C. McLaren; four Two-banded Monitors (*Varanus salvator*) from the East Indies, a Stump-tailed Lizard (*Trachydosaurus rugosus*) from Australia, four Changeable Lizards (*Calotes versicolor*) from India, twenty-four Black-spotted Lizards (*Algiroides nigro-punctatus*) from the Borders of the Adriatic, deposited; a Tasmanian Wolf (*Thylacinus cynocephalus*) from Tasmania, purchased; two Barbary Wild Sheep (*Ovis tragelaphus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DISTORTION OF SUN'S DISC AT HORIZON.—Prof. W. Prinz, of the Royal Observatory of Belgium (Brussels), has obtained several large-scale photographs of the setting sun, which show most distinctly the considerable deformation of the disc when near the horizon. The instrument employed was a photoheliograph by Steinheil. A reproduction of one of the photographs accompanies the note in *Mem. della Soc. degli Spettroscopisti Italiani*, vol. xxxi. pp. 36–39. In this case the ratio of the vertical diameter to the horizontal one is as $75 : 84 = 0{\cdot}893$.

THE CROONIAN LECTURE.[1]

A PECULIAR interest—the parallel of that which in the plant organism belongs to chlorophyll—attaches to hæmoglobin, for, unlike any other chemical component of the animal body, in virtue of its special chemical and physical attributes, this remarkable substance may in the strictest sense be said to possess a definite and unique physiological function.

The region of the solar spectrum which the author formerly investigated was that comprised between the lines F and Q (4861—3280). The question whether oxy-hæmoglobin presents definite absorption for light of shorter wave-lengths has since been examined. Soret, whose observations were not conducted with solutions of hæmoglobin, but merely with diluted blood, observing by the aid of his fluorescent eye-piece the cadmium spark spectrum, found that diluted blood, in addition to the absorption band in the extreme violet, exhibited two additional bands. One of these, coinciding with the 12th cadmium line (3247), he considered to be probably due to hæmoglobin; the other, coinciding with the 17th cadmium line (2743), he assumed to be caused by serum albumin, his observations having previously shown that all albuminous and albuminoid bodies, with the exception of gelatin, are characterised by an absorption band in the position of the 17th cadmium line.

Employing solutions of many times crystallised oxy-hæmoglobin of great purity and of varying concentration, and with the aid of the sparks of a powerful induction coil, the author has obtained a series of photographs of the cadmium spark spectrum with and without the interposition of the solutions. The examination of these photographs shows that solutions of oxy-hæmoglobin which are sufficiently transparent to allow the ultra-violet spectrum of cadmium to be photographed present no absorption bands corresponding either to the 14th or the 17th cadmium lines. The absorption band observed by Soret in correspondence with line 14 is, therefore, not due to the blood colouring matter, but to some other organic constituent present in the blood.

Having referred to his researches communicated to the Royal Society in June 1901, and illustrated the main facts by actual demonstrations, the author discussed (1) observations on the influence of temperature on the behaviour of oxy-hæmoglobin in the magnetic field; (2) observations on the ferro-magnetism of the ferro-albuminates.

He next dealt with the question of the specific conductivity of solutions of pure oxy-hæmoglobin. After a laborious investigation on this branch of the subject, the following conclusions were arrived at:—

(1) Although solutions of oxy-hæmoglobin possess a low conductivity, this is very much higher than has been found in the previous observations of Stewart, all of which were made at 5° C.

(2) The conductivity of solutions of oxy-hæmoglobin increases rapidly with increase of temperature, and undergoes remarkable and permanent changes when the solution is kept for even short periods at any temperature above 0° C.

These results explain the impossibility of obtaining data which can be considered trustworthy concerning the *absolute specific resistance* of solutions of oxy-hæmoglobin.

Continuing the researches contained in his first communication to the Royal Society on the results of the electrolysis of oxy-hæmoglobin, the author has found that when pure solutions of oxy-hæmoglobin are subjected to electrolysis, there occurs a separation of oxy-hæmoglobin in a colloidal, but perfectly soluble form. He has worked with currents of from 12 to 24 volts, and the intensity of the electrolysing current measured by a milliampere-meter placed in the circuit has varied in different experiments between 0·1 and 3·0 milliamperes.

By employing an electrolytic cell in which the anode is separated from the kathode by an animal membrane (sheep's intestine or pig's bladder), it is seen that the first action of the current is to cause a separation of colloidal hæmoglobin in the anode cell. This colloidal hæmoglobin falls as a beautiful red cloud, leaving a perfectly colourless, supernatant liquid. On stirring it instantly dissolves.

The further action of the current is to cause a rapid and entire transfer of the colloidal hæmoglobin from the anode to the kathode cell. With an electrolytic cell, of which each compartment had a width of 5 mm. and contained 2·5 c.c. of a 1 per cent. solution of O_2Hb, complete precipitation and transfer occurs within 60 minutes.

On reversing the direction of the current by means of a communicator, the hæmoglobin returns again in the direction of the positive current into the original cell from which it started.

The author adduced evidence which proves that the precipitated colloidal, but yet perfectly soluble, hæmoglobin represents the undecomposed molecule of the blood-colouring matter.

The probable nature of the process which occurs under the influence of the current was discussed, as well as the character o.

[1] "On Certain Chemical and Physical Properties of Hæmoglobin" By Dr. Arthur Gamgee, F.R.S., Professor Emeritus of Physiology in the Owens College. Read before the Royal Society on March 13.

the process which leads to the transfer of the hæmoglobin in the direction of the positive current. This process is considered to be of the same nature as the phenomena studied by Quincke under the name of electro-endosmose.

Special attention was directed to the importance of the facts which the author has elicited in reference to the colloidal yet soluble form of oxy-hæmoglobin. It was pointed out that all which has been said with regard to oxy-hæmoglobin applies to CO-hæmoglobin.

A typical colloid in the sense of its absolute indiffusibility through animal membranes and parchment paper, oxy-hæmoglobin differs, however, from most colloids in the facility with which it crystallises. Hitherto it has been known in its crystalline condition and in solution in water. Now in its third or colloidal form the analogy with such a colloid as silicic acid is rendered complete.

The discovery of this form of hæmoglobin enables a conception to be formed of the state in which the blood colouring matter is probably contained in the blood corpuscles. It was known that the amount of hæmoglobin contained in the corpuscles is so large that in most animals at least the whole of the water of the blood would not be sufficient to dissolve it. It was perfectly obvious, therefore, that it did not exist in the corpuscles in a state of solution, and the opinion has generally been held that these contained some unknown compound of oxy-hæmoglobin with a constituent of the stroma. It seems highly probable that in the red blood corpuscle hæmoglobin may be merely present in its colloidal form.

Finally it was pointed out that the remarkable facility with which the new colloidal form of hæmoglobin traverses such permeable membranes as the animal membranes and even parchment paper, when its solutions are subjected to electrolysis, suggests to physiologists the possibility that certain of the phenomena of absorption in the animal body may be closely connected with electromotive changes in the tissues concerned.

QUANTITATIVE INVESTIGATIONS OF BIOLOGICAL PROBLEMS.

THE first part of the new publication, *Biometrika*, was noticed in these columns on December 5, 1901 (vol. lxv. p. 106). The second part, which we have now received, bears out the promise of its founders and shows that the new quantitative methods of investigating biological problems have every claim to rank as legitimate weapons of research. The present part contains five original communications and a number of miscellanea. Dr. Warren's paper on "Variation and Inheritance in the Parthenogenetic Generations of the Aphis *Hyalopterus trirhodus*" shows that variation within the family is 60 per cent. of the racial variation, that the offspring have no greater resemblance to the mother than in sexual reproduction, but that there may be a somewhat greater fraternal resemblance than among the offspring of sexual reproduction. Mr. W. P. Elderton, in a paper entitled "Tables for Testing the Goodness of Fit of Theory to Observation," provides a set of tables useful alike to physicists, biometricians and statisticians generally who want to ascertain rapidly whether the distribution of observed data, within the limits of "a sample," is in agreement with a proposed theory. Mr. Oswald Latter, as the result of measuring 243 eggs of cuckoos and comparing them with the eggs of the clutches in which they were deposited, has come to the conclusion that there is colour-matching in 50 per cent. of cases, and in certain of the remaining cases size-matching. The bearing of these results upon Prof. Newton's theory is considered, and that theory is shown to receive confirmation therefrom. The next paper, by Dr. W. R. Macdonell, has great practical interest in connection with criminal anthropology. The author has studied the index characters hitherto used in the identification of criminals, and now shows that there is a high degree of correlation between the organs selected. He indicates the best method of dealing with the measurements, and gives suggestions for calculating uncorrelated characters "which would furnish an ideal system of identification." In connection with that most important topic, the laws of inheritance in hybrids, Prof. W. F. R. Weldon gives an account of Mendel's results of crossing races of peas which differed in one or more of seven characters. To quote the abstract of this paper:—"From a study of the work of other observers, and from examination of the 'telephone' group of hybrids, the conclusion is drawn that Mendel's results do not justify any general statement concerning inheritance in cross-bred peas. A few striking cases of other cross-bred plants and animals are quoted to show that the results of crossing cannot, as Mendel and his followers suggest, be predicted from a knowledge of the characters of the two parents crossed without knowledge of the more remote ancestry."

The notes published under the miscellanea comprise one from Prof. C. B. Davenport in which he shows that in an "abnormal" species of Hydromedusæ, *Pseudoclytia pentata*, it appears that the less typical an individual the less its fertility, and irregular individuals are more sterile than those having some sort of symmetry. The typical form and symmetry thus tend to by preserved. Prof. Karl Pearson, from a comparison of the eggs of English and American house-sparrows, is enabled to warn biometricians "against drawing conclusions from types based on the 'modes' exhibited by small samples of living forms." In another note he also shows from mummy statistics furnished by Prof. Flinders Petrie that there has been a great increase in the expectation of life since the 2000 years which have elapsed from the Romano-Egyptian epoch. Out of 100 modern English alive at ten years of age, thirty-nine survive to be sixty-eight, while not nine survived out of 100 Romano-Egyptians. Prof. Pearson also contributes a note "On the Modal Value of an Organ of Character." Miss Agnes Fry writes on variation in leaves of mulberry trees, and gives illustrations of the leaves of eight trees of different ages. From this summary of its contents it will thus be seen that the new publication is fully entitled to that support which we urged in our notice of the first part.

THE KOZLOFF EXPEDITION TO TIBET.

THE last number of the *Izvestia* of the Russian Geographical Society (1901, iv.) contains a series of very interesting letters of Captain Kozloff, the head of the last Tibet expedition. They cover the most important part of his journey, from May 1900 to October 1901, during which Kozloff and his companions, Kaznakoff and Ladyghin, explored a quite unknown country, situated between the 36th and 29th degrees of latitude and 97–99° E. longitude. A preliminary map, 27 miles to the inch, illustrates these letters.

The expedition left Tsaidam in May 1900, after having organised a meteorological station at the old Tsaidam fort, Barun-tsasak (36° 5′ N. lat., 97° 30′ E. long., 8700 ft. alt.). It crossed the high border ridge, Burkhan budda, which runs N.W. to S.E., separating the high plains of Tsaidam from the high plateau of eastern Tibet, and reached the twin lakes of the upper Hoang-ho, Jarin-nor and Orin-nor, or Lakes Expedition and Russian, as they were named by Prjevalsky. The border ridge consists here of two parallel chains, the passes through which attain the respective heights of 15,700 and 15,600 feet, while separate peaks rise another 500 or 600 feet above the passes. Under the name of Amne-machin, it is continued further S.E. in the same direction, the Hoang-ho running on the high plateau at the south-western foot of the border-ridge.

The intention of Kozloff was to explore Inner Tibet and, if possible, to reach Hlassa; but as soon as they entered the territory of Hlassa, their route was barred by a military force. Yielding to the demands of the authorities, the expedition abandoned its intention of penetrating further west, and went southwards, with the intention of visiting the Chamdo (or Tsamdo) monastery; but its route was again and again barred by military detachments, so that finally Kozloff turned eastwards, under the 30th degree of latitude, and wintered on the Dza-chu, a tributary of the Mekong, thirty miles north of Chamdo. Later on, in the spring, he crossed once more the high range of mountains which, running N.W. to S.E., separates the Mekong from the Blue River, and reached this last under the 30th degree of latitude. There the expedition made the necessary preparations for the return journey, which was resumed in April 1901, exploring the Amne-machin region on the left bank of the Yang-tse, and returning eventually to the upper Hoang-ho lakes.

Having thus described a wide curve in Tibet, the Kozloff expedition explored lands totally unknown, where the three great rivers—the Hoang-ho, the Yang-tse, and the Mekong—descend from the high Tibet plateau to the lower regions of China, and which represented a real puzzle in the orography of Asia. It now appears that the three rivers flow on the surface of the 12,000 feet high Tibet plateau, and are separated—not by fan-like radiating mountain ranges, but by ranges of mountains rising some 3000 feet above the plateau and all running parallel to each other, N.W. to S.E. In its western portion, the high plateau, deprived as it is of the rains of the monsoon region, is a dreary desert, covered with shingle; but in its south-eastern portion, the character of the plateau changes entirely. A deep erosion makes of it an alpine mountain region. Wide valleys and deep gorges alternate with stony ridges; the routes and the footpaths go down to a deep level, or lead to great relative and absolute altitudes. Regions of soft and of rough climate, of rich and extremely poor vegetation, rapidly alternate. This alpine character already appears in the basin of the Blue River, but it is still more evident in the basin of the Mekong, where the valleys are still deeper and their vegetation still more varied. Forests of fir and of a tree-like Juniperus make their appearance, as also growths of birch, wild apricots, apple trees and a variety of bushes. In the thickly wooded gorges, the expedition also found the conspicuous white Tibet pheasants (*Crossoptilon thibetanum*), the green *Ithaginis Geoffroyi*, the *Tetraophasis obscurus*, *Tetrastes Sewertzowii*, several species of blackbirds and a good number of the smaller birds of the Passeres group. On a bright clear day the forests and the meadows are full of bird-life. Small colonies of monkeys stay in close proximity to the Tangute encampments.

On June 13 the expedition reached at last the two lakes Orin-nor and Jarin-nor, whence it proceeded to Tsaidam, and then once more across the Gobi, back to Kiakhta. It appeared that everything was in order at the meteorological station, where regular observations were made for a full year. As to the collections made in Tibet, they were very rich and contained no less than 120 mammals, 600 birds, more than 600 species of plants (10,000 specimens) and about 300 specimens of rocks. Latitudes and longitudes were determined in thirteen different spots. The expedition is now back at St. Petersburg. P. K.

CATALYSIS.[1]

THE idea and name of catalytic action were introduced into science by Berzelius in 1835, apropos of Mitscherlich's work on the formation of ether. Berzelius pointed out that the action of sulphuric acid in this case was analogous to the action of dilute acids on starch, to the similar action of malt extract, to the decomposition of hydrogen peroxide by metals and oxides, and to the action of platinum on combustible mixtures of gases. According to Berzelius, catalytic force appeared to consist essentially in this, "that substances by their mere presence and not by their affinity have the power to rouse latent affinities, so that compound substances undergo reaction and a greater electrochemical neutralisation occurs." Berzelius made no attempt to explain the phenomenon; on the contrary, in a subsequent discussion with Liebig, he insisted on the great danger of attempting to explain incompletely understood phenomena by hypothetical assumptions, lest experimental investigation should thereby be hindered. Berzelius' warning was not heeded, and the neglect of it is felt to the present day.

Catalytic actions may be divided into four classes:—(1) Release in supersaturated systems. (2) Catalysis in homogeneous mixtures. (3) Heterogeneous catalysis. (4) Enzyme actions.

(1) This first division includes phenomena which may be regarded as fundamentally explained. The best-known case is the crystallisation of a supersaturated solution, for example, of Glauber's salt, by the admission of a very small trace of the solid substance with respect to which the solution is supersaturated. We notice here in the first place the characteristic disproportion between the quantity of the acting substance and the quantity of substance changed by its influence. By a particle of dust far below the limit of what is ponderable, it is possible to bring an indefinitely large quantity of supercooled solution to congelation. The smallest particle which suffices is between 10^{-10} and 10^{-12} gramme. The processes are not limited to supersaturated solutions of solids; they are applicable also to solutions of gas. In these cases a trace of a gas may cause the liberation of an entirely disproportionate amount of another gas. Then again, supersaturation is not limited to the liquid state. Vapours can be supersaturated in respect to liquids and solid bodies, and even in the case of solids, cases are known where they are supersaturated in respect to liquids, that is to say that when they are in contact with a small quantity of liquid in question they are converted into liquid. Supersaturation on the part of solid bodies in respect to the solid bodies which can be produced from them are very common. On the contrary, supersaturation of a liquid in respect to another liquid has not been observed and would be difficult to obtain.

The theory of all these phenomena is known. In all cases we have the formation of a system the stability of which is not the greatest possible under the given conditions of temperature and pressure. There are, on the contrary, other more stable conditions which are characterised by the fact that in them a new phase, that is a physically different component with other properties, makes its appearance. In the case of a supersaturated solution of Glauber's salt, this is the solid salt; in supersaturated soda-water, it is carbonic acid gas. As a rule such a new phase does not appear spontaneously if the supersaturation is not too great, and the system behaves as if it were in equilibrium; but if a small quantity of the absent phase comes in contact with the metastable system, the action is set going and the new phase increases until equilibrium is reached.

If the new phase is a solid substance, the releasing action is associated with a solid nucleus of the same composition. Isomorphous substances have also the property; other solid bodies, on the other hand, are without action. There is here opened a wide field for investigation, since isomorphous substances probably act by the formation of solid solutions, and it is to be ascertained whether solid substances which are not isomorphous with the substance concerned, but are capable of forming solid solutions with it, are active. Further, there are cases where solid bodies act without being isomorphous or without forming solid solutions. Such artificial nuclei can be prepared, for example, by allowing silicic acid to deposit in presence of a crystal and then dissolving the crystal by means of a suitable solvent. This subject has not been fully investigated, but it explains many apparent contradictions that have occurred in the investigation of this difficult subject. Whilst the nuclei in cases of supersaturation in reference to a solid phase must be of a specific nature, in the case of supersaturation with gases any gas whatever will act as a nucleus. This is in consequence of the fact that every gas dissolves without limit in every other gas, that is, forms a homogeneous mixture with it.

A given liquid can be simultaneously supersaturated with respect to different phases, for example, one can easily melt together sodium acetate and sodium thiosulphate to form a liquid, from which, by the addition of a nucleus of either salt, that salt is separated, whilst the other remains dissolved.

Supposing we had such a liquid flowing through a tube at one point of which was a nucleus of acetate and at another of thiosulphate, then each nucleus would continue to grow in its own way as the liquid circulated. We have here an example of the physicochemical possibility of certain organic processes to which Berzelius alluded, such as the formation of the most different substances in the animal body from one and the same liquid, namely the blood. If we might consider the blood as a supersaturated solution in respect to all these substances, it would be intelligible that every organ could increase its substance from one and the same liquid. It would be inadmissible to suppose that we have here a general theory of animal secretion, for the consideration only applies to heterogeneous phases.

Again, there is the question as to whether a compound which does not preexist in the liquid, but can only come into existence by the action of contained substances, is capable of exhibiting supersaturation in regard to other phases in contact with it. There are phenomena of supersaturation known to us in connection with calcium sulphate, solutions of which are so dilute that the salt must be almost entirely in the form of its ions. Since there are no ions in the solid salt there must be here a chemical change. Dilute solutions of lead salts and thiosulphates likewise show a supersaturation in respect to lead sulphide, which is formed from them by complicated chemical decomposition. Finally, the "physical development" in photography affords examples of such phenomena.

Further examples of possible physiological applications can-

[1] The phenomena of catalytic action have been the chief subject of investigation by Prof. Ostwald and his pupils during the past few years. An account of the chief results so far obtained, together with a statement of his own views of the general character of catalytic phenomena, was given by Prof. Ostwald in September last to the German Naturforscher-Versammlung at Hamburg. What is here given is a slightly abridged translation of this address. —A. S.

not be given here, but it is probable that many problems of organic life may find solution by the application of such principles. If we generalise the conditions which have been described, we see that the most essential condition is the presence of a metastable system which only passes to the more stable state by its inherent forces, after the way has been opened to it. The nucleus of the other phase is not the *cause* of the reaction in the sense that Robert Mayer uses this word, because it does not supply the free energy necessary for the process, but is only the means of starting a process which goes to completion by its own forces after it has once been started. We may now be quite clear that the same thing must hold for all other cases of contact action. It is just the want of proportionality between the quantity of the catalytically acting substance and the amount of change which makes it a necessary condition that the changes produced catalytically supply the necessary energy themselves. The recognition of this is apparent with Berzelius when he says that by such a process "a greater electrochemical neutralisation" is effected. One of the most prominent investigators of catalytic enzyme actions states that endothermic actions can never take place in this way. This is quite incorrect, for since endothermic reactions take place of themselves, that is, without catalytic influence, there is no reason for supposing that they should not take place under enzyme influence. It is, indeed, true that under this influence no reactions are possible in which there is a reduction of free (but not of total) energy. In other words, no reactions are possible under the influence of catalysts that could not take place in their absence without a breach of one of the laws of energy. The same is to be said about the view that catalysts can only have a decomposing and not a synthetic action. Organic chemistry affords many examples to the contrary. It is only necessary to refer to syntheses by the catalytic influence of potassium ethylate.

(2) Catalysis in homogeneous mixtures.

We now come to the largest and theoretically most important class of contact actions. The explanation given for the first class cannot here be applied, for while the essential thing in the first class was the appearance of a new phase, this is now excluded by definition. We get the right standpoint for regarding the new problem by adhering to the condition which has just been laid down for all systems that undergo contact action:—the system must not represent a stable condition, for such a system can undergo no change without the addition of energy. How, then, do unstable systems behave when they are homogeneous? The answer is that homogeneous unstable systems cannot exist otherwise than in a state of change. The supersaturated solution can, if the supersaturation is within certain limits, be kept unaltered for an indefinitely long time, when properly protected. A liquid, however, which without the addition of free energy can produce other soluble liquid products cannot be kept without forming these products. This change may proceed, no doubt, very slowly, so slowly that without tedious investigation specially directed to the point no change at all can be observed, but the surest basis for general conclusions that we know—the laws of energetics—demand, as a matter of fact, that the change must take place. They prescribe no numerical value to the velocity; they only demand that the velocity be not strictly zero, but that it shall have a finite value.

By these considerations we gain now for this present case the definition of a catalyst.

A catalyst is any substance which alters the velocity of a chemical reaction without appearing in the final product.

In this definition we purposely avoid expressing any view as to what is the cause of such influence. We must, indeed, take care only to state that for all catalytic actions, causes of the same kind are at work. We seek at present only a definition which will be helpful towards a scientific investigation of the question.

That the definition just given fulfils this purpose will be at once recognised, for it leads directly to inquiry into the numerical value of the acceleration or retardation, and the dependence of this on the nature and concentration of the catalysts, the temperature, the presence of other substances, &c. It is evident, and it must be insisted upon, that all attempts to propound theories for the cause of catalytic phenomena will remain useless until quantitative measurements of the kind referred to have been made.

Regarding catalysis in the sense just defined, it is an extremely common phenomenon, one, as a matter of fact, that appears wherever the velocity of chemical reaction can be measured. The well-known researches of Menschutkin furnish a capital example. He proved that for a number of different kinds of reactions, the velocity varied between very considerable limits, according to the solvent. We must regard this effect of the solvent as catalytic. We do not thereby prejudice the further question as to the actual cause; whether, for example, there is combination between the solvent and the reagents, leading to an alteration of the active masses and so to alteration of the velocity.

We may bridge over the gap between influences of this kind and others in which vanishingly small quantities of an additional substance alter the velocity to a very high degree. Hitherto only the exaggerated cases have been called catalytic, but as the difference is only quantitative a division between them is not justifiable. So far the cases which have been investigated and measured are those in which great influences are exerted by small quantities of material, but restricting ourselves even to these, the number of cases is extraordinarily great. We are especially indebted to the labours of Schönbein for an almost endless list of such reactions. Schönbein certainly did not know that he was dealing only with accelerations of slow spontaneous processes; on the contrary, he looked upon them as being initiated by catalysts. We are thus confronted with the task of subjecting the raw material of this untiring and original investigator to a quantitative revision, a labour which would engage the united activities of a whole series of workers.

I will not attempt to enumerate such cases: I will only remark that there seems to be no kind of chemical reaction which cannot be catalytically influenced, and no chemical substances, whether elements or compounds, which cannot act catalytically. Likewise the answer to the question already asked by Berzelius, as to whether there are general or specific catalysts, must be that both kinds exist. Whilst, for example, the presence of hydrogen ions accelerates most chemical reactions, so that they must be regarded as catalysts of great generality, there are, especially among the enzymes, specific catalysts which only exert their accelerating action on perfectly definite substances. The other question of Berzelius, as to whether different catalysts can produce different products from the same substance or substances and whether different possible reactions in a given system can be effected in different ways by different catalysts, must, I think, be answered in the affirmative, although no special experiments have been made in this direction.

The first theory of catalytic phenomena was set up by Liebig and for the purpose of showing that Berzelius' conception was superfluous. Liebig regarded catalysis as the direct consequence of the law of inertia. His statement is as follows:—"The cause lies in the capacity which a substance undergoing decomposition or combination, that is, in chemical activity, possesses of arousing in a body in contact with it the same chemical activity, or of making the body susceptible of the same kind of change. This capacity is best illustrated by a burning substance, by means of which similar activity is aroused in other bodies when we bring the burning one in contact with them."

Liebig has obviously not been felicitous in this explanation. His example recoils upon him, for in order to ignite the substance we do not require a burning body, but a hot one, and it is a matter of indifference whether it is hot by means of chemical reaction or from any other cause, for example an electric current. Such objections as these were raised to Liebig's view, and he found himself obliged to give his hypothesis a different form. He expressed his view in reference to sugar fermentation in the following words:—"Just as heat is capable of disturbing the statical moment in the elements of many chemical compounds, so this can happen by means of a substance of which the elements are themselves in a condition of disturbed equilibrium; the motion which its atoms possess is imparted to the atoms of the elements of sugar; they cease to persist in that state in which they form sugar and arrange themselves according to their special attractions."

This hypothesis of molecular vibrations has enjoyed grea popularity, and represents even to-day the view of many people, especially of those who have not taken part in the investigations. It has the special advantage that it cannot be disproved, since it is altogether inaccessible to a test. The scientific unfruitfulness that lies in such a "theory" was the less perceived, inasmuch as the development of the rest of chemistry was taking place in a direction where the employment of molecular hypotheses had the value of a very important scientific auxiliary

When, however, we attempt to derive from it the slightest guidance towards experimental and exploratory work, or to deduce an idea of the possible laws of catalytic actions—and this is, indeed, the only purpose of such hypotheses—we are convinced of its entire fruitlessness. That the hypothesis of molecular vibrations drove the whole matter into a blind alley is obvious from the fact that steady scientific investigation of the problem, previously prosecuted with much zeal, did not follow. For quite a long time only isolated investigators concerned themselves with describing catalytic phenomena. Schönbein himself, to whose investigations we are so much indebted for what we know of the facts, took no part in the theoretical discussions as to the causes; on the contrary, it obviously gave him pleasure to investigate phenomena for which contemporary chemistry, to which he paid little heed, could find no explanation or place of refuge.

It is possible to speak much more favourably of another view which had long before been advocated, but meanwhile had been neglected. This is the idea of *intermediate reactions.* This had its origin in the first scientific investigation of the chemical processes that take place in the lead chamber in the manufacture of sulphuric acid. Clement and Desormes, in the year 1806, in a classical research gave the explanation, still generally accepted, of the action of oxides of nitrogen in the oxidation of sulphurous acid by atmospheric oxygen. As everyone knows, this rests upon the assumption that the sulphurous acid is oxidised by higher oxides of nitrogen, which are thereby reduced to nitric oxide. This then unites again with atmospheric oxygen, and the process can begin anew. Thus a very small quantity of oxides of nitrogen serves to oxidise a large quantity of sulphurous acid. It is remarkable that at the time of the discussion between Berzelius and Liebig this case was not brought forward, and only later do we find applications of this old view to other cases where similar chemical processes are brought about. Then, however, this mode of viewing the phenomenon became more and more general, and to-day we must regard it as the oldest and most important attempt to explain certain, though not all, catalytic processes. As a rule, however, there certainly exists a weakness in this view. In confronting a catalytic phenomenon, we seek for the possible intermediate product in the formation of which the catalyst could take part, and we consider the problem essentially solved when we can fix upon such. If we succeed, indeed, in getting some of the assumed intermediate products from the materials, the view is considered to be proved. Whether such a substance is truly an intermediate product, and not merely some bye-product, is a question which is hardly raised and still less answered.

If we test the idea from our present standpoint, we find at first something contradictory in it. In order that a process can occur at all, it must be associated with the diminution of free energy. This loss depends only on the initial and final stage of the reaction, not upon its course. On the other hand, the velocity of the reaction in strictly comparable cases is proportional to this loss. Hence we should be inclined to conclude that the velocity of reaction in a given system must have the same value, whether the process is direct or indirect—whether it takes place in one leap or in several steps.

Such a conclusion would be incorrect, for besides the loss of free energy, the velocity of reaction depends upon many other factors, which are by no means all known. A well-known example is the very great influence which temperature has, an influence which counts much more than the corresponding increase of free energy. Chemical energetics also teach us that while definite generalisations may be made concerning the equilibrium of a given system, this is not the case with the actual velocity with which equilibrium is attained. There is thus no contradiction of general laws, if we assume that a certain course of reaction takes place more quickly through an intermediate substance than it does directly. Nothing can be said for, but something against, the view that this is generally the case.

Coming back now to our classical example, which indeed in other respects will be historical, we can assume that sulphurous acid is oxidised more slowly by the oxygen of the air than by the two reactions. Oxidation of sulphurous acid by nitrogen peroxide and oxidation of nitric oxide by atmospheric oxygen run concurrently, although the concentration of the intermediate products must necessarily be smaller than the concentrations which act in a direct reaction. Whilst, however, we may regard this view as scientifically founded, there is still a chief thing wanted. The velocity of the reaction concerned must be actually measured, and until this is done one can only speak of a conjecture and not of an explanation, and what is said here is true in general for the assumption of an intermediate reaction. No catalytic acceleration is explained, unless it is also shown that the intermediate reactions actually take place more rapidly than the direct reactions, under the given conditions. Up to now, no case of this kind has been satisfactorily investigated, and no such explanation actually proved for a given case. I certainly hope that this gap will not long remain, as investigations directed to this point are approaching their conclusion.

If we assume that in certain cases the correctness of the theory of intermediate products is proved (which to all appearances is the case), we have the further question, whether all catalyses will find an explanation in this way. I believe this question may certainly be answered in the negative. I believe that there are a number of cases in which such an explanation is not applicable. In particular, I see no possibility of explaining the retarding catalytic influences by the assumption of intermediate products, for if a reaction goes more slowly *via* the intermediate products than in the direct path it will take the latter, and the possibility of intermediate products has no influence on the process.

Another theory of catalysis has been put forward by Euler. Starting from the assumption that all chemical reactions are reactions of ions and that the velocity depends on the concentration of active ions, he supposes that the catalytic substance has the property of altering the concentration of the ions. In accordance with this alteration in the concentration, the velocity of the reaction must also alter.

So far as I can see, such a theory is admissible, that is to say, it would usually be possible to make the assumption without contradicting the laws of general chemistry. Whether or not ultimately contradictions would appear, cannot be foreseen at present. There appears to be one difficulty in the fact, often observed, that two catalysts acting together effect a much greater acceleration than would be calculated from the sum of their separate effects. It is not obvious how, by the simultaneous action of the two catalysts (for example, Cupriion and Ferriion), so much larger quantities of reactive ions could be formed than these can form acting apart.

One may say of this theory, then, that it might explain some catalyses, but by no means all.

A more complicated case of catalytic phenomena is found in processes where one of the substances taking part in the reaction acts also in the capacity of catalyst. Among the possibilities of this *auto-catalysis*, I will only mention the case of a reaction producing an accelerator. This occurs, for example, in one of the best-known reactions, the solution of metals in nitric acid. The nitrous acid here formed increases in a high degree the velocity of reaction of the nitric acid, whence arise the following phenomena:—If the metal is brought into pure acid, the reaction begins with extreme slowness. In the same degree as it progresses, it becomes more rapid and in the end tumultuous. When this period is passed, the process slows down and ends with a velocity converging on zero.

This stands in striking contradiction to the usual course of reactions, which begin with a maximum of velocity and, owing to the gradual consumption of active substances, become constantly slower.

Physiological analogies present themselves irresistibly at this point. We have here a typical *fever* phenomenon. Another important physiological fact can be illustrated in the same way, *habit* and *memory*. I have here two specimens of the same nitric acid, differing only in this, that in one a small piece of copper has been already dissolved. I now bring two similar pieces of copper foil into the two acids, which are at the same temperature. You see that the acid which has already once dissolved the copper has become "habituated" to the work and begins instantly and vigorously to carry it out, while the other unpractised acid does not know how to begin with the copper, and sets about its work so clumsily and so slowly that we will not wait for it.

That we are here dealing with catalysis by means of nitrous acid will be obvious when I add some sodium nitrite to the dilatory acid; the copper is now at once attacked and dissolved.

(3) Heterogeneous Catalysis.

The best-known case of heterogeneous catalysis is the action of platinum on combustible mixtures of gases. Whilst previously the chief interest centred round mixtures of hydrogen and oxygen, it has now passed for practical reasons to the combustion of sulphur dioxide to trioxide. In this case we are concerned, no doubt, with slow reactions, although it may be admitted that, for example, in the case of electrolytic gas, no formation of water is perceptible at the ordinary temperature in the absence of a catalyst. But the regularity of the alteration of the velocity with the temperature justifies us in the opinion that after all there is a very small velocity of reaction even at the ordinary temperature. The extremely small value is in accordance with the general fact that a gas reaction takes place very slowly. This important fact appears, for example, in the experiments of Berthelot and Péan de St. Gilles. The ester formation from acid and alcohol was compared in two experiments of the same kind, in one case the substances being liquid, in the other gaseous. Even if the experiment does not permit of an exact calculation as to whether the retardation may be fully explained by the great reduction of concentration, or whether, as is more probable, it goes beyond that, it is not to the point. It is sufficient to know that by transition to the state of gas, the velocity of the reaction is reduced to about 1/1000th.

It is possible now to set up a theory of the accelerations just mentioned. If we suppose that in the gaseous system, at a given temperature, one part is replaced by a liquid or acquires a density corresponding to the liquid state, then in this part the reaction will take place proportionately more quickly, and the liquid part of the materials will be converted into the final products. If then the liquefying or condensing source is of such a nature that it goes on condensing fresh quantities of materials as fast as the old are being used, these will react quickly and the result is acceleration of the reaction. That such is the case in the action of platinum on gases is quite possible. I do not wish to assert by this representation that the catalytic action takes place in such a way, but only to point out a possibility as to how it might take place. We should then have the simplest and purest case of an accelerating intermediate reaction to which I have already referred.

As Prof. Bredig has recently told me, it is possible to represent the mechanism of such an acceleration by means of a fluid medium in which small masses of another fluid are suspended. If this suspended liquid has the property that in it the reaction of the substances present can take place more quickly than in the main mass of the liquid, the portions of the reagents residing there will be the first to undergo change. The products will diffuse into the enveloping liquid, and thus new quantities of reagents will enter, since diffusion is always at work regulating the concentration. In this way the whole quantity of the reagents will successively find a way through the suspended liquid and react there, and the result is an acceleration of the reaction.

Bredig supposes that this view may be applied to the case where a catalyst is present in a colloidal state in the liquid. As is known, Prof. Bredig and his pupils in a series of remarkable investigations have demonstrated the manifold and energetic catalytic actions which are brought about by colloidal platinum and other colloidal metals prepared by him. He also pointed out that the extremely active catalysts occurring in nature, the enzymes, occur likewise in a state of colloidal solution or suspension.

These views have no other pretension than to be views which can be brought to an experimental test. I must not omit to draw attention to the fact that it is the view of catalysts as accelerators that has made it at all possible to put forward notions which can be so tested. Let anyone try to attain the same end by means of molecular vibrations.

(4) Enzymes.

Berzelius had no doubt that the conversion of starch into sugar by means of acids was to be classed with similar conversions by means of malt extract. The same view was held by Payen and Persoz, who isolated the active substance, diastase, or at least prepared it in a concentrated form. The same view holds good for Liebig and Wöhler, who in an excellent research studied the decomposition of amygdalin under the catalytic influence of emulsin.

The later investigations of the laws of enzyme action have, in my opinion, brought to light nothing which gives ground for a fundamental distinction between the two kinds of action. On the contrary, the researches of Bredig, before mentioned, have displayed a much more thorough-going correspondence than might have been expected.

We shall look upon the enzymes, therefore, as catalysts which arise in the organs during the life of the cell and by whose action it discharges the greatest part of its duties. Not only are digestion and assimilation from beginning to end regulated by enzymes, but the fundamental life activity of most organisms, that is to say, the acquisition of the necessary chemical energy by combustion in atmospheric oxygen, takes place with the definite cooperation of enzymes, and without this would be impossible, for free oxygen is known to be a very inert substance at the temperature of organisms, and without an acceleration of the reaction, the maintenance of life would be impossible.

Berzelius had already pointed to the decisive importance that attaches to enzymes in the economy of the living being. As a matter of fact, if we put the fundamental question, "what is the physicochemical criterion of the phenomena of life?" the answer will be, "an automatically regulated production and use of chemical energy, for the animation, maintenance and increase of the living thing." We have three different means of influencing the velocity of chemical reaction—temperature, concentration and catalysis. Of these three, the first cannot be obtained for the organism at its will. We see, indeed, that in the higher animals, in which especially complicated and delicate functions are to be fulfilled, there is complete freedom from the influence of temperature, inasmuch as they provide themselves with thermostatic appliances by means of which their body temperature can be maintained constant between certain limits. Concentrations are in many ways limited by the solubility of the substances concerned. There remains only one generally applicable means of regulating the velocity of the reactions—the application of catalysts—and this without doubt admits of the solution of the problem in ideal completeness.

I must not go further into the physiological question, but I did not wish to omit pointing out the importance of catalysis in this direction. This seems to me to be at the present time especially necessary. The older chemistry, with its facts and theories, which were concerned with the preparation and the systematic and genetic relations of substances, without regard to the laws of equilibrium and change, has proved in many respects unproductive in the explanation of physiological phenomena, and it seemed as if chemistry and physics were altogether unable to contribute anything decisive towards solving the riddle of life.

On the other hand, I should like to point out with all reserve that physical and general chemistry, in the domain of which the greater portion of this question lies, is a very young science. Those of you who were present at the Naturforscher Versammlung in 1892 will remember that it first, so to speak, "came out" there like a full-grown young lady. Hitherto she has found so much to do in her own house that she has only been able occasionally to pursue her labours in other regions, but it cannot be denied that many a hand has wished to pluck the fruits without knowing what to do with them.

It is my full and repeatedly expressed opinion that by means of the later advances of chemistry there lies before physiology a development which will be in no degree less important than that which was brought about by Liebig in his time by the first systematic application of chemical science.

So far as the properties of the enzymes are concerned, these have hitherto been investigated mainly in a qualitative way. Quantitative work meets with the great difficulties which lie in the alterability of the substance, associated, as a rule, with the loss of catalytic power. The enzymes hitherto investigated show essentially the chemical properties of albumenoids, but the question of their chemical nature is by no means yet settled. I should like to express my conviction that a more thorough investigation will disclose other intermediate stages between albumenoid products with which enzyme activities have been shown to be associated and the more simple compound substances of organic chemistry. Thus, for example, the catalytic acceleration of some oxidation processes which are characteristic of hæmoglobin seems to be maintained in its non-albumenoid derivatives, especially in hæmatin, and a following out of these relations in the decomposition products of the colouring matter of the blood would be of no slight interest.

In a few cases in which the cause of the velocity of an enzyme action has been studied in such a way as to be completely free from objection, contradictory results have appeared; while some authors have found a thorough-going agreement with the simple laws which are applicable to inorganic catalysts, others have found discrepancies.

From a hitherto unpublished article which lies before me, and in which I am inclined to place great confidence, I gather as a matter of fact that the time law of enzyme actions differs from the simplest scheme of reaction velocities. This question is, however, not yet ripe for discussion.

The question of the range of substances which can be altered by a given enzyme in a certain manner (for example, hydrolysed) is likewise in the first stage of solution, and there seems to be here similar multiplicity of function to what is found in the case of other catalysts.

The beautiful investigations of E. Fischer have shown that at any rate the very slight differences which nowadays we know in chemistry as stereochemical can bring about alteration in the action of a given enzyme. As to whether this rests on the asymmetric character of the enzyme itself or on other grounds appears to me not to have been decisively ascertained.

I must hasten to a conclusion. I have set myself the task of pointing out the broad provinces of a fertile land, which only here and there shows the first beginning of systematic cultivation, but of which the fruitfulness and importance is beyond all question. Even if the land lies outside the region to which the chemistry of the past was acclimatised, still our restless science has already begun with its new implements to make the new soil fruitful. That it is not only a chemical interest that makes the work grateful I think I have shown you by examples of its physiological application. It is also evident, from the examples which we already have of the application of this auxiliary, that the scientific knowledge and investigation of catalysis must have vast consequences in technical applications. The last great triumph of German technical chemistry, the synthesis of indigo, which will revolutionise the agricultural conditions of whole countries, contains as an essential factor a new catalysis. The oxidation of naphthalene by means of sulphuric acid with speed can only be brought about in the presence of mercury. The sulphuric acid itself, it is hardly necessary to say, is prepared by a catalytic process, whether we use the old or the newer method. When we consider that the acceleration of the reaction by catalysis is achieved without consumption of energy, and so proceeds in this sense *gratis*, and that in chemical industry, as in all other, time is money, we perceive that the systematic utilisation of catalytic appliances is likely to lead to the most thorough-going changes in manufacturing processes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The Government Education Bill has been the subject of much discussion since Mr. Balfour described its provisions to the House of Commons last week. Public opinion is decidedly in favour of the creation of local educational authorities, but it is felt that unless these new bodies are made responsible for elementary as well as secondary education, the main object of the Bill will be lost. As the president of the National Union of Teachers pointed out at the conference at Bristol, there would still exist in the same district "separate authorities for primary and secondary education, with their useless and unnecessary administrative expenditure, their jealous rivalries and interminable friction." The only way to end this state of things is to make each constituted local authority responsible for the whole of the educational work in its district. There must be no clause making it optional to adopt the elementary part of the measure, for in many cases this would mean that there would still be competing schools and educational agencies instead of an organised system. The members of School Boards who have a real knowledge of education would naturally be absorbed by the local authorities, and those who are more identified with sectarian and political interests would be left to find another platform for their polemics. The views of teachers in primary schools are expressed in the following resolution brought before the Bristol conference by Mr. R. Waddington:—"That conference expresses approval of the main principles of the Education Bill, 1902, under which may be created local authorities controlling and maintaining all forms of education within wide areas, and hereby records its satisfaction with the Government's desire to place our educational system on a sound basis; but is of opinion that the measure cannot become educationally effective unless the permissive clauses of the Bill relating to elementary education be struck out, and it be made compulsory upon the local authorities to take over the control of elementary as well as of higher education." If the Government decide to withdraw the optional clause the measure will meet with general approval from most educationists.

Prof. R. Meldola, F.R.S., has been appointed by the President of the Board of Education a member of the Teachers' Registration Council, which has just been created to consider claims to be admitted to the Register of Teachers.

The Lord Mayor of Liverpool has issued an appeal for funds to establish a Liverpool University upon the University College of the city. To effect this, about 330,000*l.* will be required, of which there has already been promised no less than 145,000*l.* by leading citizens. The present value or possessions of the College itself amount to more than 500,000*l.*; and the additional sum of 330,000*l.* which is asked for is to complete its equipment as a university. The existing resources of the College, the endowment of chairs and lectureships, amount to 186,300*l.*; the sites acquired and buildings erected and in course of erection, 251,550*l.*: fellowships, scholarships and prizes, 32,800*l.*, exclusive of value of fellowships and scholarships established by annual gifts or granted by city and county councils, the Royal Institution, the Ladies' Educational Association, the Tate trustees, and other bodies outside University College; endowments for maintenance, 20,275*l.*; and day training college hostel and endowment, 10,000*l.* The total of 500,925*l.* does not include the value of books in the library and apparatus in laboratories, nor does it take account of sums, amounting to many thousands of pounds, given to the college year by year for immediate expenditure, nor of the annual income of the affiliated schools of architecture and applied art, public health and tropical medicine. The additional lectureships to be endowed include electrotechnics, geology and chemistry, besides others in connection with commerce, engineering and medicine.

SCIENTIFIC SERIAL.

American Journal of Science, March.—The ventral integument of trilobites, by C. E. Beecher. In previous studies of trilobites the author had not thought it worth while to illustrate the character of the ventral integument, but a recent discovery by Jaekel necessitates the separate consideration of this structure. From a study of a specimen of *Ptychoparia striata*, Jaekel has deduced an entire reconstruction of the appendages and anatomy of the trilobite. An examination of well-preserved specimens of Triarthrus, several photographic reproductions of which accompany the paper, leads to the conclusion that the deductions of Jaekel are erroneous.—Igneous rocks from eastern Siberia, by Henry S. Washington. The specimens examined included a foyaite from East Cape, comendite, quartz-porphyry, rhyolite, obsidian and monzonite from Iskagan Bay.—A cosmic cycle, by Frank W. Very.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman. The present instalment is devoted to a consideration of *Limnocyon verus*, *velox*, *medius* and *dysodus*.—An experimental method in the flow of solids and its application to the compression of a cube of plastic material, by J. R. Benton. Frames of parallel wires were cast into the centre of a cube of Wood's metal. After the cube had been distorted beyond the elastic limits in a testing machine, the fusible metal was melted off and the structure of the framework examined. The condition of the wires after varying treatment is shown in a series of diagrams.—On the occurrence of monazite in iron ore and in graphite, by O. A. Derby.—The molecular weights of some carbon compounds in concentrated solutions with carbon compounds as solvents, by C. L. Speyers.—Clarence King, by S. F. Emmons. An account of the life-work of the late Clarence King.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 6.—"Experimental Researches on Drawn Steel.—Part i. Magnetism and its Changes with Temperature.—Part ii. Resistivity, Elasticity and Density, and the Temperature Coefficients of Resistivity and Elasticity." By J. Reginald Ashworth. Communicated by Prof. Schuster, F.R.S.

When magnets are heated and cooled and the cyclic state is reached, the relation of intensity to temperature is expressed by the equation

$$I_t = I_0 (1 + a t),$$

and the coefficient, *a*, almost universally is negative. But if a magnet be constructed of pianoforte steel wire, of large enough dimension ratio, then the coefficient is positive and the magnet gains in magnetism as the temperature rises. An attempt to trace the cause of this abnormal behaviour of pianoforte steel has led to a complete experimental investigation of the temperature coefficient of a magnet. Experiments on this wire when in the commercial drawn state, in the annealed condition, and when glass hard showed that it was only in the first state that an incremental coefficient exhibited itself, and it thus appeared that the drawing was responsible for the abnormal behaviour of the pianoforte wire. Samples of such wire were then obtained representing every stage in the manufacture from the rolled rod through annealing and tempering to the utmost stage of drawing, and from experiments on them it was demonstrated that the positive coefficient was developed by moderate drawing, but that extreme drawing tended to reduce it to zero.

The intensity of residual magnetism is remarkably increased by drawing, so that at last it is 200 per cent. greater than at first.

The relation of the curves of magnetisation of a very long thin wire of drawn steel, when cold and when hot, was next traced, and is highly interesting, as the susceptibility hot is always greater than the susceptibility cold even at maximum intensity, and it is not until the demagnetising force has been applied that the curves intersect; with iron and ordinary steel, the intersection of the curves is always on the ascending path. The temperature coefficient of induced and residual magnetism was examined at a number of points on the upward and downward curve for both drawn steel and iron, and it appears that the incremental coefficient in the drawn steel is largest, and the decremental coefficient in iron is least, when the susceptibility is a maximum, and in general the coefficient varies with the susceptibility. Another interesting observation is that after partial demagnetisation, heating and cooling restore some of the lost magnetism, and even when the whole of the magnetism is removed and an inverse magnetism of small intensity is impressed by the reversed force, heating and cooling clear this out and restore some of the original magnetism. The bearing of these experiments on the construction of magnets of constant intensity is pointed out. Observations extending over several years are given on four magnets of drawn steel.

In part ii. the relation of drawing to resistivity, to Young's modulus, and to density is traced. Resistivity is diminished by moderate drawing, but extreme traction again increases it; the temperature coefficient of resistivity is affected inversely to the resistivity. Young's modulus increases with moderate drawing and sharply declines with extreme traction; its temperature coefficient behaves inversely, so that when the modulus is large the coefficient is small, and conversely.

Density increases throughout with traction to the last stage and is then 8 grams per cubic centimetre. Magnetic intensity and density seem to be closely related, varying proportionally over a considerable range, so that the ratio of magnetic moment to the mass approaches a constant.

Chemical Society, March 19.—Prof. Emerson Reynolds, V.P.R.S., in the chair.—Nitrogen chlorides containing the propionyl group, by Dr. Chattaway. A description of chloroderivatives of propionanilide obtained by the interaction of hypochlorous acid with propionyl derivatives of aniline.—The constitution of the metallic cyanides as deduced from their synthetic interactions. The constitution of hydrogen cyanide, by Mr. J. Wade. The formation of both organic nitriles and isonitriles by the interaction of alkyl halides with metallic cyanides seems to imply that the latter may in some cases have either of the constitutions R.C:N and R.N:C. The author adopts an extended form of Nef's explanation for this reaction, which assumes that the metallic cyanides are really isocyanides, and that the formation of nitriles on interaction with alkyl halides only occurs where the metal is highly positive and its isocyanide capable of forming an intermediate addition compound with the alkyl halide.—The absorption spectra of metallic nitrates, i., by Prof. Hartley, F.R.S. The author has investigated the absorption spectra of various nitrates in dilute aqueous solution. A full discussion of the results will be given in a later paper.—A method of determining the ratio of distribution of a base between two acids, by Messrs Dawson and Grant. An aqueous solution of the base and the acids is shaken with an unmiscible solvent capable of extracting one of the four possible substances present in the mixture. From the amount so removed the concentration of that substance in the solution can be determined and indirectly the amount in combination.—The molecular complexity of acetic acid in chloroform solution, by Mr. H. M. Dawson. A study of the way in which acetic acid distributes itself between chloroform and water with increasing dilution leads the author to believe that a gradual dissociation of the double molecules occurs with dilution.—The existence of polyiodides in nitrobenzene solution, by Messrs. Dawson and Gawler. In studying the ratio of distribution of iodine between the two solvents nitrobenzene and aqueous solution of potassium iodine, it was found that nitrobenzene containing iodine dissolves considerable amounts of potassium iodide due to the formation of polyiodides of potassium.—Derivatives of α-aminocamphoroxime, by Dr. Lapworth and Mr. Harvey. A description of salts and other derivatives of this oxime.—Preparation of sulphamide from ammonium amidosulphite, by Prof. Divers, F.R.S., and Mr. Ogawa. When ammonium amidosulphite is slowly heated to about 70° C., it yields about 10 per cent. of sulphamide.—Hypoiodous acid, by Mr. R. L. Taylor. The author finds that the amount of hypoiodous acid formed by the interaction of iodine and mercuric oxide depends to some extent on the fineness of division of the iodine, *precipitated* iodine furnishing 44 to 52 per cent. of the possible yield, whilst *powdered* iodine gives only small amounts.—Synthesis of imino-ethers, by Dr. G. D. Lander. A description of N-aryl benzimino-ethers produced by the interaction of aromatic imide chlorides and sodium alcoholates.—Nitration of *sym.*trihalogenacetanilides, by Dr. Orton. A description of substances obtained by the action of nitric acid on *sym.*tribromacetanilide and chlordibromacetanilide.—Purpurogallin, by Messrs. A. G. Perkin and A. B. Steven. A description of various derivatives and decomposition products of this substance, obtained in oxidising pyrogallol.—Quercetazetin, by Mr. A. G. Perkin. The flowers of the African marigold *Tageteo patula* contain a crystalline yellow colouring-matter of the formula $C_{27}H_{22}O_{13}$, to which the above name was given by Latour and Magnier de la Source in 1877. Its composition is now found to be better represented by the simpler formula $C_{15}H_{10}O_8$; it furnishes like pyrone derivatives a sulphate and a potassium compound, and when fused with potash yields protocatechuic acid and an unidentified phenol.

MANCHESTER.

Literary and Philosophical Society, March 18.—Mr. Charles Bailey, president, in the chair.—Mr. J. E. King read the second and concluding part of his paper on the folk-lore of the North American Indians, from the Jesuit relations (1611 to 1637). This described funeral rites. The bodies of the dead, he said, were first buried in village cemeteries, but after eight or ten years a great "Feast of the Dead" was held, and the bones were reburied in a grave common to many villages. After the second burial, the soul went away to the village of the dead in the west. As with other savages, the burial ceremonies implied two feelings, namely, fear of the ghost and desire to maintain a bond of union with the kindred dead. Burial and cremation were said to imply different ideas as to the future of the soul after death, but this was not illustrated by Indian beliefs, for the Indians buried their dead and also believed in their continued existence in another world. They also held the doctrine of metempsychosis, as was shown in the practice of resuscitating dead chiefs by passing on their names to living representatives. The Canadian Indians had a special form of burial for children who died in infancy; so had the ancient Romans, and so had the Hindus, West Africans, and other tribes and nations. The Hindus and Maoris, however, regarded the spirit of an infant with dread. The Canadians and other nations looked upon such spirits as helpless and pitiable, and the mode of burial adopted indicated a belief in rebirth. The paper concluded with a quotation from Lescarbots, written in 1612, which anticipated the doctrine of survival in culture.—Mr. R. F. Gwyther read a paper on the conditions which determine the rate of propagation of an earth tremor.

PARIS.

Academy of Sciences, March 24.—M. Bouquet de la Grye in the chair.—On a non-suppurative form of osteomyelitis, by M. Lannelongue. Although acute osteomyelitis is ordinarily accompanied by the staphylococcus discovered by Pasteur in certain rare forms of the disease, the symptoms of which are given in detail, this staphylococcus is always accompanied by other micro-organisms, in one case a streptococcus, in another a *Bacterium coli*, and in another a short bacillus as yet undetermined.—Remarks relating to the demonstration of the therapeutic properties of the methylarsenate of soda, by M. Armand Gautier. Remarks on a communication on this subject by M. Mouneyrat.—The extension of Lagrange's theorem to viscous liquids and the conditions at the limits, by M. P. Duhem. The theorem of Lagrange, extended to viscous liquids, is incompatible with the conditions that liquids ought to verify along solid walls.—The direct hydrogenation of the oxides of carbon in presence of various finely divided metals, by MM. Paul Sabatier and J. B. Senderens. If in the reaction between nickel, carbon monoxide and hydrogen the temperature is raised much above 250° C., a certain proportion of carbon dioxide is always found among the products, which at 380° C. may amount to as much as 10 per cent. of the whole. The effect of replacing nickel by other metals was then examined. With cobalt the reaction proceeds exactly as with nickel, without any secondary reactions. Neither platinum, palladium, iron, nor copper gives rise to any methane under similar conditions.—On a theorem of Frobenius, by M. de Séguier.—On commutative homogeneous linear differential expressions, by M. George Wallenburg.—Oscillations peculiar to a network of conductors in electrical distribution, by M. J. B. Pomey.—On forces which act on a cathode flux placed in a magnetic field, by M. H. Pellat.—Hertzian waves in storms, by M. Firmin Larroque. In examining the effect of very distant storms, it was found that the suppression of the horizontal plate in the apparatus rendered the system inert, but that the suppression of the vertical portion of the apparatus had no effect upon the sensibility of the apparatus. The electrical oscillations are therefore horizontal. If the storm was not so distant, less than 300 kilometres, the inverse effect was generally observed.—Contribution to the study of sounding pipes, by M. C. Maltézos.—The specific heat of bodies at the absolute zero, by M. Ponsot. The author deduces by thermodynamical reasoning that at the absolute zero two systems of solid bodies comprising the same elements have the same specific heat, and discusses several particular cases.—On the boiling-point of selenium and on some other pyrometric constants, by M. Daniel Berthelot. The measurements were carried out by the interference method previously described, the necessary uniformity in heating being achieved by the use of an electrically heated nickel spiral. The boiling-point of selenium was found to be 690° C., or 25° higher than that hitherto admitted.—On the thermal equivalent of dissociation and of vaporisation, and on the heat of solidification of ammonia, by M. de Forcrand.—On a monosodium acid orthophosphate, by M. H. Giran. It has been supposed from the experiments of Zettnow that the crystals which cover the sticks of commercial metaphosphoric acid were a variety of orthophosphoric acid. It is now shown that these crystals consist of a sodium salt of the composition $NaH_5(PO_4)_2$.—On sesquisodium phosphate, by M. J. B. Senderens. The sodium phosphate described as new by M. Joulie in a recent paper in the *Comptes rendus* was discovered in 1882 by MM. Filhol and Senderens.—The action of the halogen ethers on the sulphocarbonic compounds of secondary amines, by M. Marcel Delépine.—On some new compounds of methylene, by M. Marcel Descudé. In presence of zinc chloride, trioxymethylene condenses readily with acid chlorides, the products being obtained of the types $R.COO.CH_2Cl$ and $(R.CO.O)_2CH_2$. A list of new compounds prepared by this reaction is appended.—Cane sugar in the food reserves of phanerogams, by M. Em. Bourquelot.—On the digestion of the mannane of the tubercles of orchids, by M. H. Hérissey. The mannane of the tubercles of orchids can, like the albumens, be transformed into mannose by the action of soluble ferments present in the plant.—The action of sulphurous acid as an antidote against *la casse* in wines, by M. J. Laborde. It has been shown that the destructive action of the oxydase on the red colouring matter in wine, the disease known as *la casse*, can be prevented by the addition of sulphurous acid. It is here shown that the contact of sulphurous acid and the oxydase alone is not sufficient to destroy the oxydase, and that it is the oxygen of the air which appears to be the principal agent of destruction in this case.—On the geological section of the *massif* of the Simplon, by M. Maurice Lugeon.—On the fragments of pumice found on the ocean floor, by M. J. Thoulet.—On radiometry and its application to pelvimetry, by M. Th. Guilloz.

DIARY OF SOCIETIES.

THURSDAY, April 3.

Röntgen Society, at 8.30.—X-Ray Diagnosis of Renal Calculus: Dr. Ch. Leonard.

Linnean Society, at 8.—On the Composite Flora of Africa: W. Spencer Moore.—A Halonial Branch of *Lepidophloios fuliginosus*: Prof. F. E. Weiss.

FRIDAY, April 4.

Institution of Civil Engineers, at 8.—Compressed-Air and its Applications: L. G. Crawford.

Geologists' Association, at 8.—Klondike, its Geology and Mining: Prof. H. A. Miers, F.R.S.

MONDAY, April 7.

Society of Chemical Industry, at 8.—Some Recent Improvements in the Photography of Colour: E. Sanger Shepherd.

Victoria Institute, at 4.30.—Locusts and Grasshoppers: Rev. F. A. Walker.

TUESDAY, April 8.

Royal Institution, at 3.—Recent Methods and Results in Biologica Inquiry: Dr. Allan Macfadyen.

Institution of Civil Engineers, at 8.—*Papers to be further discussed*: The Greenwich Footway-Tunnel: W. C. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.

Society of Arts, at 8.—Street Architecture: Prof. Beresford Pite.

WEDNESDAY, April 9.

Society of Arts, at 8.—Ceuta and Gibraltar: Major-General John F. Crease.

THURSDAY, April 10.

Mathematical Society, at 5.30.—A Note on Divergent Series: Dr. Hobson, F.R.S.—Stress and Strain in Two-dimensional Elastic Systems: Prof Love, F.R.S.

Institution of Electrical Engineers, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

Royal Institution, at 3.—The Oxygen Group of Elements: Prof. Dewar, F.R.S.

FRIDAY, April 11.

Physical Society, at 5.—An Apparatus for Vapour-pressure Measurements: Mr. Grant.—(1) The use of Cathode Rays for Alternating-Current Measurements; (2) An Experiment on the Current Growth in an Inductive Circuit: Mr. Morris.—An Electric Heater: Dr. R. A. Lehfeldt.—Note on the Compound Pendulum: S. A. F. White.

Royal Astronomical Society, at 5.

Malacological Society, at 8.

Royal Institution, at 9.—Problems of the Atmosphere: Prof. Dewar, F.R.S.

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