THURSDAY, JULY 21, 1898.

TECHNICAL MYCOLOGY.

The Utilisation of Micro-organisms in the Arts and Manufactures: a Practical Handbook on Fermentation and Fermentative Processes, &c. By Dr. Franz Lafar, Vienna. With an introduction by Dr. Emil Chr. Hansen, Copenhagen. Translated by Charles T. A. Salter. In two volumes: Vol. i. Schizomycetic Fermentation. With plate, and 90 figures in the text. Pp. xviii + 405. (London: Charles Griffin and Co., Ltd., 1898.)

BEFORE Pasteur published his great work on "Fermentation," most people would have scouted the idea that bacteria could ever play any very important part in technical and trade affairs. But when this work appeared it became evident that, as shown in the description of the processes concerned in brewing and vinegar-making, a new era had been inaugurated. Still it was scarcely, even at that time, anticipated that bacteria would come to play their present important part in the arts. Although it is impossible at first sight to appreciate the immense strides that are now being made, it is manifest when one comes to look over such a volume as that under review, that technical mycology has materially aided, and sometimes in a measure even superseded, much of the work of the chemical laboratory. In the case of chemical work, *results* are merely recognised and set forth, but, from bacteriological work, explanation of the chemical changes are afforded. It is interesting to notice what a successful attempt has here been made to amalgamate the scientific with the practical. Hitherto the scientific part of bacteriology has been looked upon as science pure and simple, except in its relation to the production of disease, and to such conditions as putrefaction and fermentation. Now, however, that the scientific investigator and the practical worker are co-operating, it is evident that the import of bacterial processes is greater than could hitherto have been imagined. It has certainly been one of the greatest gains of bacteriology that the study of the physiology of fermentation and other technical processes should have been undertaken by Pasteur and Hansen. Under their leadership there have been brought together a number of eager workers who have from time to time made valuable contributions to our knowledge of mycology. Most of such work, however, is to be found only in technical or scientific journals, with the result that the technologist has not always had the benefit of the opinion of the scientific expert, whilst on the other hand the scientific expert has too frequently worked unavailingly along lines which at the time appeared to lead to no practical result. In the work before us, and in one or two others, especially those that have come from the Danish laboratories, we have a series of text-books, if one may so speak of them, in which both kinds of investigations have been carefully sifted, analysed, collected, and accessibly arranged. It has too long been the case that in certain of the technical laboratories founded specially for the purpose of bringing bacteriological science to bear on technical work, the scientific worker has been kept too closely to analyses and to work having direct relations to technical processes, with the result that in many cases his work has been dwarfed, and he has had little time to devote to original investigation of any kind.

Hansen, in the preface to the work before us, puts the matter pithily and forcibly in the following words:—

"It is true that an intimate connection with practical conditions sets fresh tasks before the investigator, and exerts on the whole a sufficiently stimulating influence; but on the other hand, the same circumstance gives rise to the danger of diverging into by-paths, and neglecting the strict scientific conditions of investigation. Since these Stations and Laboratories are, as a rule, maintained by a circle of practical men for whom they work, the investigators appointed thereto are often subject to regrettable pressure. Even though, otherwise, a certain amount of freedom is allowed them in these institutions, they labour under the great difficulty of being obliged—whilst engaged in the task of scientific investigation—to be ready at any moment to give assistance—coupled with analyses and any wished-for disclosures—to the parties interested. Still further difficulties arise when practical men foolishly intermeddle in scientific investigations, and especially when results that shall be immediately available for practical utilisation are impatiently demanded—results which, however, are only attainable by scientific investigation, and cannot be forced on at pleasure. . . . The result of these vexed relations between Scientists and practical men has been to call into existence a quasi-scientific literature by which neither Science nor Practice is benefited—a result which every one who has the healthy development of this subject at heart must greatly deplore and endeavour to improve according to his ability. These conditions are, however, in existence, and we must take them into account."

Such being the state of affairs, we welcome most heartily a work which deals in a thoroughly scientific spirit with technical bacteriology, and in the first volume of Dr. Lafar's book we have the part fulfilment of the promise of an exceedingly useful work. Dr. Lafar has given a scientific basis of bacteriology, offering classifications and methods of working which can now be styled classical. But in addition he has drawn up a kind of parallel between the micro-organisms of disease and the micro-organisms that play a part in various technical processes; the whole forming a thoroughly good foundation on which to build up the more technical part which follows. This following part includes a systematic description and classification according to their power of doing work in special technical processes of various groups of micro-organisms. After dealing briefly with the question of spontaneous generation, the author goes on to speak of the various theories of fermentation, and closes the introductory part of the work with a short account of the special organisms that are associated with this process. He then, in the first division of the main body of the book, devotes a section to the schizomycetic fermentations and to the general morphology and physiology of schizomycetes. This is followed by a section on the general biology and classification of bacteria: in this latter section the behaviour of bacteria under the influence of physical agencies is specially dealt with, and mention made of their relation to one another in the various symbiotic, metabiotic, and antagonistic conditions. The account of the various classifications of the bacteria, commencing with that drawn up by O. F.

Müller, and ending with those now generally in use, is excellent; although it is evident from what is here laid down, that our classification of micro-organisms is as yet to a large extent empirical, and that there is great need for a classification constructed on a thoroughly sound and scientific basis. The principles of sterilisation and pure cultivation are given succinctly but very clearly. The section devoted to the heat-resisting bacteria, their place in nature, and their importance in the fermentation and food-stuff industries, is one of considerable interest. The principal organisms in this group are described as the *Bacillus subtilis* and its congeners, the *Clostridium butyricum*, the genus Granulobacter, and various other organisms associated with the butyric acid fermentation, the fermentation of cellulose, the "retting" of flax and hemp, and the production of rancidity of fats.

The relation of the study of the life-history of these various organisms to the preservation of milk, meat, eggs, vegetables and fruit is fairly carefully considered, as are also the lactic fermentation and the allied decompositions, special stress being laid on the production of optically active organic compounds by fermentation, on the artificial souring of cream, the coagulation of milk, and on the importance of the part that various lactic acid bacteria play in the processes of distilling, brewing and vinification; and in the preparation of fodder, the making of brown hay into sweet ensilage and sour fodder. Then the work done by bacteria in tanning, in the manufacture of sugar in the conditions known as "ropiness" in milk, wine, beer, and other liquids are all somewhat fully and interestingly treated. A special section is devoted to the decomposition and transformation of organic nitrogenous compounds; this, of course, constitutes a very important part of the work, and, in conjunction with the section on oxidising fermentation, affords a very large amount of information on the bacterial processes involved in the breaking up of various organic compounds. It is interesting to note how closely these processes are associated with those of fermentation of cheese and of similar proteid substances.

Altogether this volume, the first of two, is an exceedingly interesting and valuable contribution to the study of technical mycology. The work of translation is well done, but there are one or two slips which might with advantage be corrected in future editions: for instance, "typhus" is throughout used for "typhoid," this, of course, being a literal translation of the German *typhus* without the term *abdominalis*, which is always added to indicate our *typhoid* fever. It need scarcely be mentioned that the work will probably be hailed by English workers with gratitude, but we may point out that the term "mycology" will convey to the general reader very little idea as to the scope of the work. Many years ago a work was published in this country to which the title "Pathological Mycology" was given, a work which was largely overlooked because of its title. Since then this same title has been used abroad, where the significance of the word appears to be more fully appreciated. We think the translator would have been wise had he selected some title more generally "understanded of the people" for what, after all, must to a certain extent be a popular work. There will, however, be a considerable demand for this book amongst those who are engaged in pathological and technical bacteriology, who, of course, will appreciate both the title and the work; but the translator must expect to find that some, at least, of his possible readers will pass over this book simply because they do not understand the title.

Messrs. Griffin have done their part in a thoroughly workmanlike fashion, and we congratulate both author and translator in having their work placed so well before the reading public.

PARTIAL DIFFERENTIAL EQUATIONS.

Leçons sur l'intégration des équations aux derivées partielles du second ordre à deux variables indépendantes. Par E. Goursat. T. I. pp. viii+226; T. II. pp. 344. (Paris: A. Hermann, 1897, 1898.)

A DIFFERENTIAL equation, in its usual form, states an analytical problem with a certain assumption as to the form of the answer. It implies the existence of a dependent variable, capable of being differentiated so far as the order of the equation indicates; and the solution of the equation consists in discovering a relation among the variables, free from differential coefficients, such that the given differential equation may be derived from it. The question at once arises: what is the most comprehensive form of solution? Is it possible in every case to define an integral relation connecting the variables equivalent to the differential equation in the sense that not only is the differential equation derivable from it, but every possible relation consistent therewith is included as a particular case in the integral equation? In the early days of the infinitesimal calculus it was observed that ordinary differential equations could be obtained by eliminating constants; while partial differential equations could be derived by the elimination of constants or of arbitrary functions. In some cases the reverse process of starting with the differential equation and arriving at an integral relation, involving arbitrary constants or functions, or both, was found to be practicable; and it came to be taken for granted that integral relations of this kind always existed, the only difficulty being that of discovering them.

But, with the advance of function-theory, the peculiar difficulties of the subject have gradually become more evident. It is true that, with regard to ordinary differential equations and partial differential equations of the first order, the general form of solution has been established, and the hypothesis of the earlier mathematicians justified; but when we come to partial differential equations of the second and higher orders, the aspect of the problem is radically changed. In most cases it is hopeless to attempt to assign an explicit form of the general integral, or even to prove its existence; and we have to content ourselves with the study of solutions subject to certain special limitations. Thus we have the problem of Dirichlet in the theory of potential; or again the problem of Cauchy, which forms the leading idea of M. Goursat's original and fascinating treatise.

To explain what this means, let us take the case of an equation of the second order with two independent variables, say $\phi(x, y, z, p, q, r, s, t) = 0$, the notation being as usual. Assume x, y, z, p, q functions of a single variable, subject solely to the condition $dz = pdx + qdy$; we thus have a multiplicity of one dimension, which may be called an orientation of the first order. In general by means of $\phi = 0$, the relations $dp = rdx + sdy$, $dq = sdx + tdy$, and those derivable from them by differentiation, it is possible to find a definite expansion for z, which formally satisfies the differential equation and also contains the given orientation: if the expansion is convergent in a certain domain, this defines z as an analytical function of x, y. Geometrically, if we take x, y, z as point coordinates, the assumed orientation consists of an arbitrary curve, with an arbitrary, but continuous, distribution of tangent planes along it, enveloping a developable surface; if we like, we may regard it as a thin ribbon cut out of a developable. The process sketched above is equivalent to finding an integral surface containing the aforesaid ribbon, or in other words containing the given curve, and touching at each point of it the given associated tangent plane. The problem of Cauchy for an equation of the second order is to find a solution capable of being specialised, by the choice of arbitrary constants or arbitrary functions, or both, so as to contain any given orientation of the first order. Such a solution is said to be general in Cauchy's sense, as distinguished, for example, from one that is general according to Ampère's celebrated definition.

It may happen that the orientation of the first order, M_1 say, is such that the relations $\phi = 0$, $dp = rdx + sdy$, $dq = sdx + tdy$ are, for every element of it, equivalent to only two independent equations; in this case Cauchy's problem becomes indeterminate, and there are an infinite number of integral surfaces containing M_1, which is then said to be a characteristic of the first order of $\phi = 0$. It is an exception for an equation of the second order to admit of a multiplicity M_1; since

$$\phi\left(x, y, z, p, q, \frac{dp}{dx} - s\frac{dy}{dx}, s, \frac{dq}{dy} - s\frac{dx}{dy}\right) = 0$$

has to be satisfied identically for all values of s, and this leads to a number of distinct relations, not generally compatible. One of these is always

$$\frac{\partial\phi}{\partial r}dy^2 - \frac{\partial\phi}{\partial s}dxdy + \frac{\partial\phi}{\partial t}dx^2 = 0; \ . \ . \ .$$

on every integral surface this equation defines a system of characteristic curves.

Throughout the whole treatise the theory of characteristics plays a predominant part. Thus in Chapters i.–iii., which deal with the equation of Monge and Ampère $(Hr + 2Ks + Lt + M + N(rt - s^2) = 0)$, it is shown with admirable clearness how the success of Monge's method of integration depends upon finding integrable combinations of the differential equations of the characteristics. The cases of partial or total failure are discussed as well as those of success; and the reader thus becomes familiar with the *rationale* of the process, instead of merely acquiring facility in applying a method which, in some way that he hardly understands, leads (with good luck) to the required solution. Chapter iii., in particular, contains a large number of important applications very fully worked out.

M. Goursat's first volume concludes with an important chapter on the general theory of characteristics and on intermediate integrals. The notion of characteristics is extended to the second and higher orders, and it is shown, among other things, (1) that every equation of the second order possesses in general two distinct systems of characteristics of the second order; (2) that two characteristics of the second order belonging to two distinct systems, and having in common an element of the second order determine one, and only one, integral surface (p. 193). All equations of the second order may be arranged in four classes according as they have (1) two different systems of characteristics, each of the second order (this is the general case); (2) two systems, one of the first order, one of the second; (3) two systems, usually distinct, each of the first order; (4) one system of the first order.

The second volume begins with an account of Laplace's method of treating linear equations, which may be profitably compared with the discussion of the same subject in Darboux's "Théorie des Surfaces." After this come two chapters, of the highest interest and importance, on systems in involution and on Darboux's method of integration. The first of these deals with systems of equations which admit of solutions involving an infinite number of arbitrary constants, and introduces us to ideas of great value and generality which have been developed by various mathematicians, including M. Goursat himself. The chapter is, to a great extent, introductory to the one on Darboux's method, which immediately follows, and which will probably be found the most engrossing part of the work. The leading idea is that of finding integral combinations of the differential equations of characteristics; not necessarily of the first order, as in Monge's method, but of the second, third, or higher order: thus, for instance, Liouville's equation $s = e^z$ is completely integrated by proceeding as far as the characteristics of the second order. M. Goursat very justly remarks that Darboux's method is the most powerful as yet available, and includes most others, for instance those of Monge, Ampère, and Laplace, as particular cases. In order that it may succeed, it is necessary that every integral of the proposed equation should also be an integral of another partial differential equation which has in common with the given equation an infinity of integrals depending on an arbitrary function, while at the same time the second equation must not be satisfied by all the integrals of the first (II. p. 190). The main practical difficulty is that it is generally impossible to say beforehand whether a given equation admits of solution by this method or not. By means of Lie's theory of transformation-groups it is, however, possible to construct a variety of equations to which Darboux's method may be successfully applied.

The next chapter deals with equations of the kind called by Ampère those of the first class; this is followed by one on transformations; and the treatise concludes with a somewhat miscellaneous chapter containing various generalisations of the preceding theory.

A work so attractive as this, and written by an author so well known, is assured of the favourable reception which it thoroughly deserves; taken with M. Goursat's previous work on equations of the first order, and M. Darboux's "Théorie des Surfaces," it will provide mathematical students with an excellent guide to what has been done in this part of analysis. One way, amongst many others, in which M. Goursat's treatises are likely to be very useful is in giving practical illustrations of Lie's methods. Lie's colossal work on transformation-groups is so very abstract and, at the same time, so exhaustive that it must, we fear, repel the great majority of readers; still it is hardly rash to predict that his ideas, as time goes on and they become more familiar, will prove to be of extreme value and fertility, and profoundly affect, not only the theory of differential equations, but almost every branch of analysis. It should be added that M. Goursat points out that Ampère employed contact transformations of a general character more than seventy years ago; and it is, in fact, one of the author's objects to recall attention to Ampère's remarkable memoirs in cahh. 17, 18 of the *Journal de l'Ecole Polytechnique.*

G. B. M.

OUR BOOK SHELF.

Our Weights and Measures: a Practical Treatise on the Standard Weights and Measures in use in the British Empire, with some Account of the Metric System. By H. J. Chaney. Pp. viii + 164. (London: Eyre and Spottiswoode, 1897.)

THE Superintendent of Weights and Measures gives in this book an authoritative account of the present practice in regard to the various weights and measures used in trade or for the purposes of manufacture. The origin and history of ancient systems are briefly traced so far as to show how our present system comes to be what it is, and references are carefully given to other treatises and to Acts of Parliament on all points of importance.

The book is well illustrated. Some of the views are of antiquarian interest: *e.g.* the beautiful pictures showing the interior of the Pyx Chapel at Westminster Abbey, a depository for standards since the Norman period; but most of the illustrations have reference to weights and measures in actual use, and to the arrangements for their inspection and verification. Local inspectors of weights and measures will no doubt look on this book as a very useful and, indeed, indispensable compendium.

Teachers and writers of books on arithmetic would do well to take to heart the remarks on pp. 112–114. Thus not only is a list given of those weights and measures which alone need be taught to the exclusion of various customary and local designations which, from a national point of view, are now obsolete, but it is well pointed out that a few hours' actual weighing and measuring would make the children in schools more at home with standard weights and measures than many hours of bare learning of the tables.

The last section of the work is on weights and measures used for special purposes; it includes, for instance, an account of engineers' gauges and standards, and gives tables of particulars of the Birmingham wire gauge, Whitworth's and Seller's screw threads, the B.A. small screw gauge, and several other standard gauges.

Practicum der Wissenschaftlichen Photographie. By Dr. Carl Kaiserling. Pp. xii + 404. (Berlin: Gustav Schmidt, 1898.)

IN this volume of about 400 pages we have a work which will be read by most photographers, whether amateur or professional, who are familiar with the German language, for, besides covering a great deal of ground, the subject is treated of in much detail. Although portraiture and landscape photography are included in the text, the author presents the subject more especially for those who employ photography as a means of aiding them in their scientific investigations. Thus, for instance, the medical man is enlightened as to the best means of illuminating portions of the human body to get the best effects from his point of view, and to photograph with success anatomical sections for demonstrations or collections. Microphotography is also treated at some length, and is well illustrated by some fine autotypes.

It must not be assumed that the optics and manipulations are here somewhat ignored at the expense of the new lines on which the book has been written. Both of these come in for their full share, and are well discussed and described, besides being copiously illustrated. Most of the new lenses are referred to at some length, and are accompanied by numerous tables for determining the lengths of exposures under different conditions. Methods of obtaining positives and enlargements, stereoscopic photography, Röntgen photography, and photography in natural colours, besides processes for reproduction, are all in their turn dealt with individually; and the reader who wishes to specialise in any one or more of these branches will find ample information in these chapters.

Enough, perhaps, has been written to show that this book is not only a useful *vade-mecum* for the student of science who wishes to obtain the best results in his special line of work, but is a valuabie addition to our photographic literature. The illustrations are numerous, and there is, what is often absent from a great many German books, a good index.

Principles of Mechanism: a Treatise on the Modification of Motion by means of the Elementary Combinations of Mechanism, or the Parts of Machines, for use in College Classes, by Mechanical Engineers, &c. By S. W. Robinson, C.E., D.Sc., till recently Professor of Mechanical Engineering in the Ohio State University. Pp. xv + 309. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

THE main value of this work may not unfairly be said to consist in its 350 illustrations of elementary combinations of mechanism (in many cases more curious than useful), and in the descriptions appended thereto. In regard to the scope of the book, and, it may be added, the degree of clumsiness of expression of which the author is capable, we may quote the second sentence of the introduction: "In Principles of Mechanism we find the application to machines, of the principles of kinematics, or cinematics, the elementary combinations of mechanism of which machines, being studied separately."

A good many rules, useful in the drawing office, are exemplified; but the fundamental principles on which they are based are for the most part left unnoticed. Thus in Fig. 297 we have a complicated drawing of the fixed and moving centrodes of certain mechanisms, but we search the book in vain for any demonstration of the method of instantaneous centres on which the construction depends.

In Fig. 301 the curves of velocity-ratio of crank and connecting-rod are shown: the accompanying description identifies them with the fixed and moving centrodes of the motion. There is no appeal to the fundamental principles involved. In fact the book before us, however suitable for reference by an inventor, seems to us quite unfit for a student's text-book.

Introduzione allo Studio dei Silicati. By Dr. E. Ricci. (Milan: Ulrico Hoepli, 1898.)

IN this pamphlet the author seeks to classify the complex group of the mineral silicates, and he claims for his arrangement the merit of simplicity. The distinction between the hydrous and anhydrous silicates is abandoned, and all mineral silicates are grouped in the two primary divisions of orthosilicates and metasilicates. As simple orthosilicates he includes zircon, phenacite, and willemite with the Peridot family (olivine, sepiolite and calamine); and with the double orthosilicates he groups the felspars, the felspathoids, the micas, the garnets, the epidotes, the tourmalines, the zeolites, and the chlorites. Among the metasilicates we find the pyroxenes and amphiboles, with serpentine beryl and the copper silicates. The table of classification given at the end of the work includes most of the common rock-forming minerals, but does not deal with the rarer species. The author finds himself unable to accept Prof. E. Dana's nomenclature of the silicates, and, as will be seen from the foregoing summary, uses the terms orthosilicates and metasilicates for groups having very different limits to those assigned to them by the American mineralogist.

The Blood; how to examine and diagnose its Diseases. By Alfred C. Coles, M.D. Pp. xi + 260. Plates vi. (London: J. and A. Churchill, 1898.)

THE book before us is practically confined to the consideration of morphological methods. The author has endeavoured to collect what is known concerning the morphological changes as determined by staining reagents in the cellular elements of the blood in different diseases. He has further included a description of the methods requisite for the identification of certain parasites, and Widal's method of serum diagnosis in typhoid fever. The information contained in the book is, so far as concerns method, accurate; and those who prefer to have the methods for the examination of the blood in one volume, not under the head of the respective disease, as is done in the larger text-books of medicine, will no doubt find Dr. Coles' work useful. Some of the author's explanations and definitions are, however, not as exact as they should be; for instance, his remarks on chemiotaxis on p. 86, especially on negative chemiotaxis, are certainly original. The terms are not ordinarily used in the sense of the author. More might also have been done in the direction of a fuller bibliography.

F. W. T.

Notes on Volumetric Analysis. By Arthur Thornton, M.A., and Marchant Pearson, B.A. Pp. viii + 80. (London: Longmans, Green, and Co, 1898.)

THE series of twenty-seven experiments described in this book will serve as an elementary course of practical work in volumetric analysis, as they illustrate all the simple processes of neutralisation, oxidation, iodometry, and methods of precipitation. The instructions are clear; and the student who follows them should have no difficulty in performing the experiments, or in carrying out other exercises of the same type, while at the same time he should become skilful in general volumetric work.

A First Year's Course of Practical Physics, adapted for Beginners and Junior Students. By J. F. Tristram, M.A., B.Sc. Pp. 50. (London: Rivingtons, 1898.)

A SERIES of very elementary exercises on measurements of length, area, volume and density are given in this little book. Neither the plan of the book, nor the experiments described, present any novelties; but this will not prevent the volume from being of use in instructing young pupils in the methods of weighing and measuring.

The Doctrine of Energy: a Theory of Reality. By B. L. L. Pp. ix + 108. (London: Kegan Paul, Trench, Trübner, and Co., Ltd., 1898.)

THE argument that the conception of energy embraces and supersedes the conception of matter; that, in fact, the universe is not made up of two real things—matter and energy—but only one, was supported by the author from the standpoint of physical science in a volume published eleven years ago. The question is now presented as viewed from a metaphysical standpoint, and it will doubtless prove as interesting to students of philosophy as it is to students of physics.

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.*]

Solfatara Gases.

WE have for a considerable time been occupied with an extensive study of the gases emanating from the earth in various parts of Italy with the object of detecting the presence of argon and helium, and possibly of other elements they may contain.

The first part of this work has already been published (*Gas delle terme di Abano, Gazzetta Chimica Italiana*).

We are now completing the study of the gases of the Solfatara di Pozzuoli, Grotta del Cane, Grotta ammoniacale, and of Vesuvius. In the spectrum of those of the Solfatara di Pozzuoli, which contain argon, we have found a sufficiently bright line with the wave-length 531·5, corresponding to that of corona 1474 K, attributed to coronium, an element not yet discovered, and which should be lighter than hydrogen. This line has never before been observed in earthy products. Besides we have noted the following lines:—653·5, 595·5, 536·2. In the spectrum of the gases gathered from the Fumarole of Vesuvius we have observed the lines:—769·5, 631·8, 572·5, 636·5, 441·5, and again 595·5. All these lines do not belong to the spectrum of argon or helium; they show a coincidence or proximity only with some unimportant lines of various elements, such as iron, potassium, titanium. Considering the conditions of our experiments, the presence of these elements in the gases we have studied is not probable. The line 572·5 is near to one of nitrogen, but being the only visible line of the spectrum of this gas, it cannot be attributed to it. Besides coronium we have thus probably other new elements in these gases.

We are diligently pursuing their investigation.

Padua.

R. NASINI,
F. ANDERLINI,
R. SALVADORI.

The Spectrum of Metargon.

THE letter which Messrs. Ramsay, Travers and Baly have addressed you on this subject calls for one or two remarks. The similarity between the carbon and metargon spectra does not only apply to the green band, but to the whole of the visible spectrum, and also, as my previous letter pointed out, to the ultra-violet band commonly ascribed to cyanogen. With the ordinary coil discharge I could see nothing but carbon bands, and it is contrary to all experience that two dissimilar bodies should give complicated spectra so much alike that a two-prism spectroscope can detect no difference between them. With the Leyden jar a strong continuous spectrum appeared, and, overlapping it, some of the lines of argon. The blue argon lines were absent, but my examination was not sufficiently detailed to allow me to say, that the visible lines were those commonly found in the "red spectrum." Neither with nor without the jar did I see any line which could not be assigned either to carbon or to argon, but I should have liked to try a stronger jar and a more powerful coil. With the jar there seemed to me to be signs of decomposition of the gas, as, on removing it again, the carbon lines were weak at first and only gradually returned. The pressure in the tube was rather high; and if the tubes experimented upon by Prof. Ramsay and his coadjutors were all at the same pressure, I should not attach much weight to their observation that the carbon oxide spectrum did not make its appearance after introduction of oxygen, for that spectrum only shows well at lower pressures.

I ask for nothing more than a "suspension of judgment" until a more detailed spectroscopic examination has been made. Only such an examination should include observations at atmospheric pressures, and also at lower pressures than those used so far.

It is also highly desirable to try Leyden jar sparks of much greater intensity than those I saw used at University College. I agree with Prof. Ramsay in so far that the brilliancy and whole appearance of the carbon spectrum does not suggest its being due to an impurity. Taking the spectroscopic evidence by itself, it points in the direction that the gas under examination is a compound of carbon either with argon or with a so far unknown body, and that it may be mixed with a considerable quantity of argon. If that is the case there seems, as far as I know, no *à priori* reason why sparking with oxygen should necessarily remove the carbon. The ratio of specific heats must take care of itself. It is a matter of the greatest interest to pursue the subject; for the origin of the spectrum, whatever it may turn out to be, will probably throw much light on the source of the spectra of comets and of carbon stars.

ARTHUR SCHUSTER.

Liquid Hydrogen.

MR. HAMPSON seems insatiable of contradictions. He has produced a vast quantity of irrelevancies with which I have no concern. But I have denied the accusations he brings against me, and every single statement of his that is relevant. Yet he still complains that I do not deny enough. It is absolutely false to say that I appropriated or profited by any plan, idea, or statement of Mr. Hampson's, either directly or indirectly. I was never informed of his visit, far less of any of the plans he brought to the Royal Institution, nor would anything have induced me to look at them. I have been long enough in this "temple of science" not to know what that might involve. Mr. Hampson got at my assistant behind my back, and persuaded him to look at the plans. I infer from the public correspondence, that he saw that they would not work, and he told Mr. Hampson why they were unworkable.

Even with this assistance it took Mr. Hampson another year to perfect a provisional specification of his invention, which is totally devoid of any plan or drawing of a workable apparatus.

In the meantime Linde had completed his invention, and the Royal Institution went on working on its own lines, just as it did before Mr. Hampson was heard of, and as it would have done had he never been heard of at all.

Like the rest of us, Mr. Hampson was using ideas and principles established by other men, and was trying to apply them and combine them so as to reach a given result. He has no property either in the principles or in the idea of combining them, or in anything except the particular combination to which he himself may give concrete form.

Other men besides myself have successfully combined these principles without any help from Mr. Hampson.

Long before Mr. Hampson's patent was published, I said at the Chemical Society in 1895: "It is a mistake to attribute to Linde the idea of using the cumulative withdrawal of heat for the first time in his apparatus, but he *has succeeded in making a workable industrial machine, and that is a very important step.*"

In the Society of Arts *Journal* I said: "Both Onnes and myself used or economised the temperatures of the expanding gas in order to cool the gas coming forward, but Linde was entitled to *every credit for elaborating a machine in which this was done as perfectly as possible.*"

Further, in the *Chemical Industry Journal* the following passage makes my position clear: "He (Prof. Dewar) was willing to give all credit to Dr. Hampson, Dr. Linde, and any one who effected improvements in these investigations. All he asked was that they should not exaggerate their claims, and seek to block the way to other people who were working in the same direction. Dr. Hampson did not appear to realise that anybody else could be working in the same path and utilising the same ideas. It was quite clear, however, from the facts before them, that that was precisely the state of affairs in the present case."

Such extracts show that I have recognised to the full the merits of the true inventor within the limits of his just claims.

JAMES DEWAR.

Summer and Winter in Relation to the Sunspot Cycle.

THE quality of a winter season may be fairly estimated from the number of days on which the minimum temperature has gone below a given limit; and the quality of a summer season, from the number of days on which the maximum temperature has gone above a given limit. Two tables issued from Greenwich are here convenient for use; one giving frost days (since 1841), the other days on which the temperature reached or exceeded 70°. There are more of the latter than of the former; seventy-seven on an average, as against fifty-five frost days (in September to May).

We may roughly call a winter season *severe* or *mild*, according as it has more or less than the average number of frost days; and a summer season *hot* or *cool*, according as it has more or less than the average number of hot days (in the sense specified).

Confining attention to the groups of five consecutive years having a sunspot maximum, or minimum, year third (or central), I propose to inquire whether there is anything in the winters and summers of these groups pointing to sunspot influence.

(The sunspot maximum years are 1848, 1860, 1870, 1884, 1894; and the minima, 1843, 1856, 1867, 1879, 1890. Winters may, for brevity, be designated by the year in which they *end;* thus, 1842 means 1841–42. In the tables exceptions are marked *e*).

The following statements regarding winter may be verified:—

(1) *In five-year groups having each a sunspot maximum year third (or central), there are generally more mild winters than severe.*

(2) *In five-year groups having each a sunspot minimum year third (or central), there are generally more severe winters than mild.*

The proof is in these tables:—

A. Max. groups.	Severe.	Mild.
1846–50	2	3
1858–62	2	3
1868–72	3	2*e*
1882–86	1	4
1892–96	2	3
	10	15

B. Min. groups.	Severe.	Mild.	Av.
1841–45	3	2	
1854–58	5	0	
1865–69	2	2	1
1877–81	3	2	
1888–92	4	1	
	17	7	1

The first table shows one exception to the rule (maximum of 1870). The five years' total, however, it may be stated, is *under*, not *over*, the average.[1] In table B the winter 1840–1 has been included, though the record properly begins with 1841. It was a severe winter. The table has one group with an average winter, so that this group may be considered neutral.

Coming now to the summer season, proof is offered of the following:—

(3) *In five-year groups having each a sunspot maximum year third (or central), there are generally more hot summers than cool.*

The corresponding and opposite statement for minima seems hardly warranted by the present data. The tables are these:—

C. Max. groups.	Cool.	Hot.
1846–50	2	3
1858–62	2	3
1868–72	1	4
1882–86	3	2*e*
1892–96	2	3
	10	15

D. Min. groups.	Cool.	Hot.
1841–45	4	1
1854–58	0	5*e*
1865–69	2	3*e*
1877–81	4	1
1888–92	4	1
	14	11

Here we have one exception to our third rule, the group for min. 1884 showing two hot summers and three cool ones. The table D has three cases pointing one way, and two the other.[2]

In view of these facts, I have sought light from a different quarter, taking the mean temperature of the four months May to August, and dealing with the series (from 1841) in the same way.

We thus obtain the following tables for summer:—

E. Max. groups.	Cool.	Hot.
1846–50	1	4
1858–62	2	3
1868–72	2	3
1882–86	4	1*e*
1892–96	2	3
	11	14

F. Min. groups.	Cool.	Hot.
1841–45	4	1
1854–58	3	2
1865–69	3	2
1877–81	3	2
1888–92	4	1
	17	8

Comparing E and F with C and D, we find general agreement of the two former (E and C), the exceptional group, 1882–86, remaining,[3] while table F gets rid of the exceptions of D. In fact, while the summer seasons 1854, 1855, 1856, and 1867 had more than the average number of hot days, the mean temperature of May to August was, in each year, *under* the average.

[1] It is right to say that this criterion would make the neutral case in B an exception.

[2] In the curve of hot days, there is evidently a long wave of variation, which may complicate matters.

[3] The sunspot maximum of 1884, I may point out, was abnormally low.

We thus seem to be warranted in the fourth proposition.

(4) *In five-year groups having each a sunspot minimum year third (or central), there are generally more cool summers than hot.*

From the present point of view, then, it would appear that in our climate sunspot maxima tend to be associated with a preponderance of mild winters and hot summers; and minima with a preponderance of severe winters and cool summers.

The latter condition of things we should now be near; if we suppose a minimum in 1901, then we might expect at least three of the winters, 1899–1903, to be severe, and three of the summers cool, in the sense indicated.

A further feature may here be noticed. If we arrange the summers and winters in vertical series, according as they are in maximum (or minimum years) one year after maximum, two years after, &c., to the extent of five on either side, there are in these vertical series, I find, only two cases of uniformity throughout, viz. these: (1) *All summers of minimum years have been cool;* (2) *all summers in the fifth year after minima* (and therefore near maxima) *have been hot.* This agrees with the foregoing. A. B. M.

Rotifers in Lake Bassenthwaite.

IF the occurrence of *Asplanchna* as a conspicuous member of the pelagic fauna of lakes has not hitherto been recorded in Britain, it can only be attributed to the lack of attention in this country to the systematic investigation of our fresh-water fauna. On the continent of Europe and in North America, *Asplanchna priodonta* with its variety *helvetica* and other members of the genus are constantly recorded as among the commonest constituents of the lake plankton. I have on several occasions found *A. priodonta* in lochs near Dundee in swarms similar to that described by Prof. Hickson, and I have no reason to suppose that there is anything exceptional in the phenomenon. Mr. John Hood, of this city, a veteran student of the Rotifera, tells me that its occurrence under these conditions has long been familiar to him. He states that the domestic water supply of Dundee, which always contains a variety of pelagic organisms, was on one occasion rendered quite turbid by swarms of the same species.

It must be remembered that Hudson and Gosse's monograph was written at a time when the tow-net had hardly begun to be employed in fresh-water investigation, and that many of the common pelagic species were either unknown, or, like *Notholca longispina* for example, very little known to the authors.

Prof. Hickson does not state whether any males were present in the gatherings obtained by him. It is probable, as Wesenberg-Lund has recently pointed out (*Zool. Anz.*, March 7, that the appearance of any one species in large numbers is an indication of the approach of the "sexual period," which is always preceded by a period of very rapid parthenogenetic reproduction. W. T. CALMAN.

University College, Dundee, July 5.

THE STORY OF THE SMITHSONIAN INSTITUTION.[1]

IN this sumptuous volume, produced with all that excellence of type, paper, and illustration, in which so many of the American official publications excel, the story is told of how the Smithsonian Institution was founded, and of the work which it has done in its first half-century.

The Smithsonian Institution, like our own Royal Society, has something of a semi-official connection with the Government. Without being a Government department, or deriving its funds from Government, it is in close correspondence with the ruling powers in respect to scientific matters, advises them upon scientific questions, administers funds voted by Congress for specific scientific purposes, and in general keeps an eye upon the scientific side of many national undertakings.

It is presumably in recognition of this semi-official character of the Institution, that the President of the United States has written a brief but interesting preface to the present volume. In this preface Mr. McKinley recalls how, in 1796, George Washington, in his farewell address to his fellow-countrymen, said "Promote, then, as an object of primary importance, institutions for the general diffusion of knowledge, for in proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened"; and how, thirty years later, "an Englishman, James Smithson, as though influenced by these words, bequeathed the whole of his property to the United States of America in trust 'to found at Washington an establishment for the increase and diffusion of knowledge among men.'"

James Smithson, the benefactor who is thus commemorated, was born in 1765, and was known in his youth as James Lewis Macie, he being in fact an illegitimate son of Hugh Smithson, afterwards Duke of Northumberland, by Elizabeth Macie, a cousin of the Percys, who, at the time of his birth, was a widow.

This fact of his parentage is important, not only as explaining why James Macie subsequently took the name of Smithson, and so gave its name to the Smithsonian Institution, but as explaining also one strong motive which influenced him in founding that institution; for, all his life, it seems, he smarted under a sense of injustice, and was determined that in some way he would attain to fame, though excluded from hereditary rank. "The best blood of England," he once wrote, "flows in my veins; on my father's side I am a Northumberland, on my mother's side I am related to kings, but this avails me not. My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten."

Smithson was a student of science, and did some sound scientific work. He was a Fellow of the Royal Society, and contributed twenty-seven papers to the *Philosophical Transactions*, the *Annals of Philosophy*, and the *Philosophical Magazine*—papers which, in the opinion of Dr. S. P. Langley, whose biographical sketch of Smithson fronts this history, "give the idea of an assiduous and faithful experimenter." Nevertheless he did not by this path attain any such eminence as would justify him in hoping for the immortality which he coveted, and there can be little doubt that it was at least in part his consciousness of this fact which led him to follow the remaining path to fame, that of a munificent benefactor to the branch of learning which he loved.

In his later years he was a great sufferer. He lived chiefly in Paris, where he cultivated the friendship of Arago. From Arago's "Eulogy on Ampère" Dr. Langley gives a very interesting extract, which is worth quoting in full, as giving us a vivid glimpse of Smithson's declining years, and a rather touching picture of Arago's friendship with him.

"Some years since in Paris I made the acquaintance of a distinguished foreigner of great wealth, but in wretched health, whose life, save a few hours given to repose, was regularly divided between the most interesting scientific researches and gaming. It was a source of great regret to me that this learned experimentalist should devote the half of so valuable a life to a course so little in harmony with an intellect whose wonderful powers called forth the admiration of the world around him. Unfortunately there occurred fluctuations of loss and gain, momentarily balancing each other, which led him to conclude that the advantages enjoyed by the bank were neither so assured nor considerable as to preclude his winning largely through a run of luck. The analytical formulas of probabilities offering a radical means, the only one perhaps, of dissipating this illusion, I proposed, the number of the games and the stakes being given, to determine in advance, in my study, the amount not merely of the loss of a day, nor that of a week, but of each quarter. The calculation was found

[1] "The Smithsonian Institution, 1846–1896. The History of its First Half-Century." Edited by George Brown Goode. (City of Washington, 1897.)

so regularly to agree with the corresponding diminution of the bank-notes in the foreigner's pocket-book, that a doubt could no longer be entertained."

It may be added, by way of sequel, "that Smithson resolved not to absolutely discontinue play (in which he found the only stimulus which could make him forget his physical suffering), but to do so with a care that the expenditure for this purpose was a definite one, and within his means."

Smithson died in Genoa in 1829, having bequeathed all his property to a nephew, Henry James Hungerford by name, and after him to any child of this nephew, "legitimate or illegitimate"; but in case of the said nephew dying and leaving no child, then all the property was, as mentioned above, to go "to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men."

Henry Hungerford died unmarried and without heirs in 1835, and Smithson's solicitors forthwith communicated with the United States Embassy in London. Then followed discussions in Senate and House of Representatives. Some senators considered that it would be beneath the dignity of the nation to receive benefits from a foreigner. Other senators considered that it would not. The House of Representatives referred the matter to a select committee, and finally the legacy was accepted, and Richard Rush, a lawyer of high standing, at one time United States Minister at the Court of St. James's, was selected to prosecute the claim in Chancery.

When Mr. Rush arrived in London he found that there were eight hundred cases in Chancery ahead of his, yet he managed to get the suit settled in less than two years, a matter "which gave rise to no little surprise," seeing that "the English lawyers themselves admitted that a Chancery suit was a thing which might begin with a man's life, and its termination be his epitaph." It is pleasant to read that this success "was due in a large degree to the extreme friendliness and consideration manifested by the British law officers, from the Attorney-General down." The suit settled, Mr. Rush took passage home in the packet ship *Mediator* with one hundred and five bags, each containing a thousand sovereigns, except one, "which," reported Mr. Rush, "contained 960 sovereigns and eight shillings and sevenpence *wrapped in paper*"—a particularity which is a little comical in face of the fact that the Treasury accounts show that the odd money which he actually paid in was eight shillings and *sixpence*.

And now, of course, the trouble began. Another eight years must pass before Congress could decide what to do with the money. Like our own Royal Society, the Smithsonian Institution had to go through a period of incubation before it could be hatched. Just as Evelyn, Cowley, Petty, and others proposed sundry schemes for giving body to the "Invisible College," so, numerous "persons versed in science and in matters relating to education" gave their views on the shape which the Smithsonian Institution ought to take. Some advocated the establishment of a university, others a central school of natural science; others, again, an institution for researches in physical science in connection with the useful arts. An experimental farm, a school of astronomy, and a meteorological bureau were other proposals; while ex-President Adams urged the establishment of an astronomical observatory "equal to any in the world," an idea for which he fought with great persistence.

At length, in 1846, the existing Naval Observatory having been organised, Mr. Adams was willing to drop his observatory scheme, which had been standing somewhat in the way of a settlement, and in that year the Act incorporating the Smithsonian Institution was passed by Congress.

To John Quincy Adams, "the Smithsonian" owes much. It was mainly by his influence that the bequest was accepted, and, when accepted, that it was resolved to keep the capital intact and spend only the interest. Next to him, the Institution is indebted for its successful foundation to Joel Poinsett of South Carolina. To Poinsett are due the main features of organisation, the plan for a national museum of science and art, and the inauguration of a system of international exchange of books. Other features are due to other men: the establishment of the library to Rufus Choate, of Massachusetts, and George P. Marsh, of Vermont; the establishment of a staff of resident investigators to Richard Rush, of Pennsylvania; and the organisation of the various branches into one whole to Robert Dale Owen, of Indiana.

For the constitution of the Smithsonian Institution we must refer the reader to the volume before us. There he will find it set forth with fulness, and supplemented with a biographical notice of every member of the Board of Regents down to the present time, and with an interesting chapter on the three successive Secretaries, Prof. Joseph Henry, Prof. Spencer Fullerton Baird, and finally Prof. Samuel Pierpoint Langley, who happily is still spared to the scientific world, and at the age of sixty-four shows no abatement in scientific ardour. That the constitution of the Institution was judiciously conceived is sufficiently shown in the brief paragraph with which the late Dr. Goode closes his chapter on "The Board of Regents": "Notwithstanding the fears so generally entertained fifty years ago, the Institution has never, in any respect, fallen under the influence of political interference. No member of its staff has ever been appointed because of the influence of powerful friends or for any reason except that he was believed to be the best man available for the place. No sinecures have been created, and no breath of suspicion has ever tarnished the reputation of any officer or employee."

And now, at the end of its first half-century, what is the scope of this great Institution, and what is the work which it carries on? "To increase and to diffuse knowledge among men," were the aims of the founder, and to these two aims—the *increase*, and the *diffusion* of knowledge—the Institution strictly addresses itself. The Library, the Publications, the Museum, the Bureau of Exchanges, the Bureau of Ethnology, the Astrophysical Observatory, the Zoological Park, and the exploration work of the Institution are some of the main branches of its system bearing upon one or other of these aims.

In most of these branches the Institution is in close alliance with the United States Government. Its library, for instance, is actually beneath the same roof as the library of Congress, and, though kept distinct, forms for practical purposes one library. It is said that the Institution reaps great advantage by this arrangement, inasmuch as it thus has access to a much larger number of volumes, while effecting a considerable saving in its funds. Indeed, it is a question whether a similar amalgamation might not usefully be made between some of our English libraries. Whatever advantages there may be in each scientific society in Burlington House, for instance, having its own library—and some advantages no doubt there are—it is obvious that a certain waste of funds and force results from the Royal, the Geological, the Chemical, the Linnean, and the Royal Astronomical Societies, all situated in the same quadrangle, being possessed of separate libraries, separate staffs of assistants, separate catalogues, and quintuplet sets of many expensive serials and books.

As with the library, so with the museum; the Government and the Institution are mutually benefited by a close alliance. The nucleus of the museum was Smithson's own cabinet of minerals, consisting of some eight or ten thousand specimens. To this were added, in 1858, the collections formed by various exploring expeditions carried out by the United States Government, which till then had been kept in the Patent Office; and in 1861, the collections accumulated by the unfortunate National Institute—a body which was swamped by its own exertions, for its income did not suffice for it to cope with the flood of materials which poured in from all parts of the world in response to its appeals. To this amalgamation of collections was given the name of the United States National Museum, the whole being placed under the care of the Smithsonian Institution, which pursues the enlightened policy of freely distributing duplicate type specimens to scientific institutions, of presenting sets of general duplicates to colleges for educational purposes, and even of lending original undescribed specimens to experienced men of science.

The Bureau of American Ethnology is also a national undertaking, placed under the direction of the Smithsonian Institution. Its germ was an exploration of the cañons of the Colorado, begun in 1867 by Major Powell, which presently grew into a survey, first geographical, then geological, and finally anthropological. In 1871 Congress made an appropriation to be expended under the direction of the Smithsonian Institution for continuing the explorations and surveys, and the organisation became "The United States Geographical and Geological Survey of the Rocky Mountain Region." In 1874 the survey was transferred to the Department of the Interior, and anthropological researches were made more prominent. In 1879 there were four bureaus engaged in surveys in the Western Territories, and these were reorganised in the present Bureau of Ethnology, under the direction of the Smithsonian Institution. Appropriations are annually voted by Congress to enable the Bureau to continue its researches, and publish its results. Its publications, however, are limited to the thoroughly digested scientific conclusions, and only represent a fragment of the enormous amount of work accomplished. What that work amounts to in bulk may be better conceived from the statement that the fireproof vaults of the "Smithsonian" contain MSS. under more than 2000 titles, besides the material for a "Cyclopædia of Indian Tribes" upon 100,000 cards.

Like the Bureau of Ethnology, the National Zoological Park is primarily American. It was commenced, that is, mainly with a view to preserving animals, and especially native animals, which were likely to become extinct. It has not, however, been so generously treated by the nation as some other departments of the Smithsonian work, and, like many things American, the American Zoo fluctuates with American politics. It began well. Dr. Langley had his dream, and a very noble dream it was; namely, to establish a park in which the wild animals might live "as nearly as possible in the conditions natural to them, so that they might breed and thrive in captivity as in their native haunts." An almost perfect spot was found for this purpose in Rock Creek, with flowing water, varied aspects, and differing soils; sunny slopes, cool hillsides, level meadows and rocky cliffs. It was purchased in 1889, and in the following year an Act was passed placing the park under the direction of the Regents of the Smithsonian Institution. The 185 living animals which the Institution already possessed, and which had hitherto been kept huddled together in low sheds and small paddocks, were transferred to the park. All was going well, when, in 1891, "the mutations of politics caused a change in the dominant political party"—then, estimates were reduced, authority to purchase animals was withdrawn, and even the question of abolishing the park was considered. Notwithstanding these difficulties, many successes have been attained, and Secretary Langley lives in hopes of more adequate Government support.

The same "knack of hoping" has to be exercised by Dr. Langley in respect to the Astrophysical Observatory. Unlike the above-mentioned departments, the Smithsonian Observatory has received no aid from Congress. This observatory, in which Dr. Langley has carried on his excellent work under the greatest difficulties, he himself describes as "a one-story building, or rather shed," erected on a site "surrounded by streets and traffic." It was erected in 1890 in the grounds of the Institution, and the expense of its erection and equipment was principally defrayed by a donation of 5000 dollars from Dr. Graham Bell, and a legacy of the same amount left by Dr. Kidder. It is to be hoped that Dr. Langley's ardent desire for a suitable permanent building on a suitable site may soon meet with a response from the nation.

The exploration work of the Institution has been very notable. Nearly every Western expedition, whether Government or private, of any magnitude, has received aid from the Smithsonian Institution. That the Government Surveys in particular, undertaken as they were for definite, practical purposes, should have the scientific eye following them, and usually a scientific corps attached to them, has been of incalculable advantage for the increase of knowledge. First came the surveys for railways and waggon-roads across the public lands of the West. Then the geological surveys of the same region. Then the explorations of the sea coast, rivers, and lakes of the States by the Fish Commission; and investigations of the North American Indians by the Bureau of Ethnology. With all these Government activities the Institution has been, either directly or indirectly, connected. In fine, to quote the words of Mr. F. W. True, who here gives their history, "the Smithsonian Institution has contributed to the work of exploring the domain of nature not only directly by setting on foot expeditions supported from its own funds, and indirectly by aiding and equipping numerous Government and private expeditions, but more remotely as well by influencing independent workers to explore in many lands, and to add new treasures to the national collections."

It is needless in a scientific journal to speak of the importance of the publication work done by the Institution. The "Smithsonian Contributions to Knowledge," and the "Smithsonian Miscellaneous Collections" are too well known to need any detailed notice. A thousand copies are distributed every year to the leading scientific libraries throughout the world. Neither is it necessary to speak in detail of the liberal policy of the "Smithsonian" in its system of international exchanges, a liberality which was furthered by the American Government and met in a like spirit by the British Government, scientific books sent as presents being exempt from duty in both countries. This exchange system, in which until 1862 the Royal Society of London took part as the forwarding agents for Great Britain, has been of immense practical service to the scientific world. Finally, the reader must be referred to the volume under review for the "Appreciations" of the scientific work accomplished by the Smithsonian Institution with which it closes. The appreciations are interesting, but could scarcely be epitomised within the space of a brief article like the present. They are mostly written by well-known scientific men in the United States: "Physics," by President Mendenhall; "Mathematics," by Prof. R. S. Woodward; "Astronomy," by Mr. Holden, Director of the Lick Observatory; "Chemistry" and "Meteorology," by Marcus Benjamin; "Geology" and "Mineralogy," by Prof. Rice; "Palæontology," by Prof. Cope, of the University of Pennsylvania; and so on through the fifteen chapters into which the "Appreciations" are divided.

Prof. Henry, the first of its three famous Secretaries, often used to say "that co-operation, not monopoly, is the watchword of the Smithsonian Institution. Its policy has always been to devote itself to such useful fields of labour as no other institution could be found ready to take up." That policy has been steadily pursued throughout this, its first, half-century of existence, and by the perusal of this volume most readers will be convinced that it has been justified by the results. H. R.

SPIDER AND PITCHER-PLANT.

IN the insectivorous plants of the genus *Nepenthes*, a form represented by a number of species and widely distributed over the Indian and Australian regions, as well as in Madagascar, the pitchers or insect-traps, which are usually regarded as expansions of the leaf-stalk, are suspended, mouth upwards, at the ends of long tendrils proceeding from the tips of the leaves. The gaping orifice, frequently strengthened and kept open by a thickening of the rim, is protected by a lid, which, while preventing the infall of rain, offers no obstruction to the free entrance of insects. To attract the attention of these animals the pitchers are frequently conspicuously coloured in their upper parts, and honey is secreted from glands scattered around the margin of the aperture and on the under-face of the lid. This gaudy and sweetened portion, designed as it is to catch the eye and act as a bait, constitutes the "attractive" area. A short distance within the cavity and below the attractive area just described, the walls of the pitcher are smooth and of a waxy consistency, so that no foothold is afforded to insects, which are consequently precipitated to the bottom of the pitfall if luckless or incautious enough to venture on this "conductive" area. The lower part of the receptacle is filled to a greater or less extent with a fluid containing, amongst other substances, potassium chloride, malic and citric acids, as well as soda lime and magnesia in smaller quantities and an enzyme, which in the presence of the acids has the power of digesting organic matter (S. H. Vines; quoted by "A. W. B.," NATURE, vol. lvii. pp. 367–368, 1898). This fluid, poured out as a secretion from a large number of glands developed in the adjacent walls of the pitcher, is usually crowded with the indigestible remains of insects, commingled with those of which the nutritious tissues are in process of decomposition under the action of the alimentary juice of the plants and of the bacteria which infest it.

The spiders of the family Thomisidæ belong to that artificial section of the order sometimes spoken of comprehensively as the wandering or hunting species as opposed to those of sedentary habit, which spin snares for the capture of prey. Some of the Thomisidæ live on the ground amongst vegetable débris or beneath stones; others on the trunks or leaves of trees; others, again—and these are the species that have attracted the greatest amount of attention—frequent flowers, and lurk amongst the petals on the watch for visiting insects. To this last category belongs the spider (*Misumena nepenthicola*) now under discussion, a species which invariably takes up its abode in the pitcher of a North Bornean (Labuan) *Nepenthes*, perhaps referable to the species described as *N. phyllamphora*.[1] In any case, whatever the name of the plant may be, the *Misumena* appears to inhabit exclusively the one species; for although several other kinds were found growing in the vicinity, they were never observed to be tenanted by spiders.

According to that skilled collector and trustworthy observer, Mr. A. Everett, who kindly furnished me with the notes forming the basis of the account here given, the pitchers in question are somewhat elongate in shape, and constricted a short distance below the rim, broadening out again as the bottom is approached, and narrowing ultimately to a vanishing point where they join the supporting stalk. Just below the upper constriction the spider spins a slight web, adherent to the wall of the pitcher. This web is not of the nature of a snare or net designed to intercept insects, but extends as a thin carpet over a small portion of the conductive area, and enables the spider to maintain a secure hold on its slippery surface. Here it lives and rears its young, no doubt feeding upon the insects which the *Nepenthes* attracts for its own use, capturing them either as they enter the pitcher, or perhaps after they have fallen into the digestive fluid below.

So far as procuring food is concerned, this spider would seem to be no better off than those of its allies which live in flowers and capture the honey-seeking insects that visit them, except in so far as it is not dependent upon seasonal inflorescence for a place wherein to lurk. But in one very important respect it must presumably score heavily in the struggle for existence—that is to say, in its means of escaping from enemies.

It is a well-known fact that almost all spiders, especially those that occur in tropical and subtropical countries, suffer immense mortality from the relentless persecution of the solitary mason wasps, which at their breeding season scour the country and explore every nook and cranny in the eager search for spiders wherewith to lay up a sufficient store of food for the voracious young wasps during the days of their larval existence. From these enemies the flower-frequenting species have no means of escape, except such as is afforded by quiescence in conjunction with the protective nature of their colours, attitudes and form. The slightest movement on their part will attract the notice of the quick-sighted wasp, and bring swift destruction upon them.

Whether or not the mason wasps have the temerity to invade the pitchers of *Nepenthes* in their quest for victims, there is no evidence to show. Possibly long-billed birds thrust their beaks into the insect-trap to extract any living things or organic débris they may contain. At any rate, the account given by Mr. Everett of the behaviour of this spider when threatened with danger, points forcibly to the conclusion that the species is subject to persecution from enemies of some kind or other. This collector found that when an attempt was made to capture them by tearing open the pitcher, the spiders, although very active, never attempted to escape from the mouth of the vessel, but ran down its inner surface, and plunged boldly into the liquid at the bottom, ultimately, if still pursued, retreating to its very base, and burying themselves amongst the remains of ants, moths, beetles, &c., with which the pitcher was more or less choked.

Although many spiders of semi-aquatic habits, such as *Dolomedes*, *Thalassius*, and some species of *Lycosidæ* plunge beneath the surface of water when threatened with danger, and escape along the stems of the subaqueous weeds; and although an example of *Araneus* (*Epeira*) *cornutus*, a terrestrial species which, however, frequents the banks of streams and marshy country, has been noticed, when disturbed, to drop to the ground, run into the water, hide beneath a tuft of weed,[1] and there remain for a minute or so before venturing to climb back to its web, I am not aware that the adoption of water as a city of refuge has ever been recorded of any member of the family Thomisidæ. These spiders, in fact, as already explained, depend for safety upon protective assimilation to their surroundings. Consequently the habit of plunging into the fluid in the pitcher of *Nepenthes*, adopted by *Misumena nepenthicola*, must be regarded, it appears, as a new instinct acquired by the species in connection with the exceptional nature of its habitat; and its behaviour carries with it the conviction that the species is constantly subject to persecution from some enemy other than man, whether it be bird or wasp.

Possibly the spiders, when once they have taken up

[1] I am indebted to my colleague, Mr. A. B. Rendle, for kindly examining the two fragments of the pitcher sent home with the spiders. Unfortunately the pieces are too small to make the identification of the species other than doubtful.

[1] Prof. Lloyd Morgan, NATURE, vol. xlvii. p. 102, 1893.

their abode in the pitcher are, like the insects that venture in, unable to get out again on account of the opposition to exit offered by the slipperiness of the walls of the conductive area. If this be so, they would be compelled, in case of attack, to seek safety in the lower parts of the pitcher; and while those too timid to take the plunge, or too weak to withstand the immersion, would be captured or destroyed, their instinctively bolder or physically hardier companions would be saved to transmit their characteristics; and so by a process of elimination and selection the instinct would be gradually brought to the state of perfection Mr. Everett has described.

Lastly, if it be wondered by what means the spider is able to resist the action of the fluid, and to regain its position of security in the upper part of the pitcher, it must be remembered, in the first place, that a great many spiders, as well as many insects, can be immersed in water and other liquids, and withdrawn in a perfectly dry state; and in the second place, that almost all spiders when dropping from their webs or leaping after prey, ensure a safe return to the spot they have left by letting out a drag-line of silk, which passes from the spinning mammillæ to the point of departure. A silken thread of this description would enable *M. nepenthicola* to climb out of the digestive fluid which retains the captured insects; while the nature of the integument and of its hairy clothing would prevent the penetration of the fluid during the short time that the spider remains beneath it.

R. I. POCOCK.

FERDINAND COHN.

ON June 25 last the career of one of the great botanists of the latter half of this century was brought to a close. During the span of a long life of seventy years Ferdinand Cohn has devoted his best energies to the advancement of botany, and the list of his papers in the "Royal Society Catalogue of Scientific Papers" bears witness to an unwearied devotion to his life work.

In his earlier years Cohn was amongst the foremost of those who were engaged on investigations into plant life and animal cells, and to the last it was the lowlier members of the vegetable kingdom that attracted his chief attention. But it was ever the striving after a deeper insight into the nature of the living organism that stands out as the keynote of his numerous researches, and the grasp which he possessed of the current problems is seen in one of his earlier papers on *Protococcus pluvialis*. In this memoir he brought forward cogent arguments in support of his view that the Protoplasm, recognised a few years before by Von Mohl as the essential living substance of plants, was identical with Sarcode, first described for animals by Dujardin; and Cohn's arguments were the more worthy of attention inasmuch as he was already familiar with, and was writing about, Infusoria. It is singular that Cohn's claims to have first established this great generalisation should have been so obscured by the work of Brücke and Max Schultze, since the memoirs of these investigators were published several years after Cohn's paper which appeared in 1850, and was shortly afterwards translated into English under the auspices of the Ray Society.

In those early years, from 1847 and onwards, new contributions to science flowed rapidly from the pen of the hard-working man. His papers on *Pilobolus*, *Empusa*, *Sphæroplea* and on *Volvox* are well known. Some of them were at once recognised as of prime importance, and were translated into English and French.

But Cohn's interest was by no means restricted to these channels, for several of his early works deal more especially with physiological problems. The injuries caused by lightning and the problems of disease also engaged his attention, and it was perhaps chiefly in connection with the latter class of questions that his later investigations were pursued. The importance of his work on Bacteria was long ago recognised, and the attitude which, in opposition to Nägeli, he maintained towards the pleomorphism of these organisms has turned out to be substantially the correct one. Naturally, however, it was not to be expected that genera distinguished at this (relatively) early period would prove to be natural ones, but the existence of independent species, also recognised by De Bary, is now everywhere admitted.

In addition to his work as a teacher and an investigator, Cohn's "Beitrage zur Wissenschaftliche Botanik" will always serve to keep his memory green in the minds of botanists. These volumes contain a large number of important papers, many of which were the direct outcome of his personal influence.

The "Kryptogamen-flora von Schlesien" also testifies to his editorial energy, and he was himself one of the most active members of the Schlesische Gesellschaft zu Breslau, and many of his papers are to be found in the records of this Society, to which also in his later years he contributed many valuable and suggestive reviews of current work; and these will always prove of permanent value to the historian of this period.

Cohn was a foreign member of the Royal and Linnean Societies of London, and the gold medal of the latter Society was awarded to him in 1895. Few men have more justly earned the respect of their fellows than he, and all might well profit by the example of his industrious career. He is gone, but his work remains as a lasting monument to his fame:—

"Sicut fortis equus, spatio qui saepe supremo
Vicit Olympia, nunc senio confectu' quiescit."

J. B. FARMER.

NOTES.

THE French Association for the Advancement of Science will this year hold its meeting at Nantes, from August 4 to 11.

THE annual general meeting of the Victoria Institute was held on Monday afternoon last, when Sir George Stokes delivered his presidential address. The subject of the address was "The Perception of Colour."

THE Council of the British Medical Association resolved at its last meeting to found as a memorial of the late Mr. Ernest Hart a scholarship to be called "The Ernest Hart Memorial Scholarship for Preventive Medicine." It was felt that no more fitting means could be found to commemorate at once Mr. Hart's great services to the British Medical Association and to the advancement of the study of preventive medicine. The scholarship, which will be of the annual value of 200*l.*, will be tenable for two years.

AT the recent Council meeting of the Iron and Steel Institute, Prof. Roberts-Austen, C.B., F.R.S., was elected to succeed Mr. Martin Dowlais as president of the Institute.

SIR MARTIN CONWAY has started for Bolivia. It is his intention to explore the high group of the Andes containing the peaks Illimani and Illampu (or Sorate). He is accompanied by the Alpine guides Antoine Maquignaz and Louis Pellissier, who made the first ascent of Mount St. Elias in Alaska last year with the Duke of Abruzzi.

PROF. MAX WEBER, the well-known zoologist of the University of Amsterdam, will leave Europe in October next, for Sourabaya, Java, to take command of a scientific expedition, projected by the Society for the Biological Investigation of the Netherlands Colonies, for the zoological, botanical and oceanographical exploration of the seas of the Indian Archipelago. The course of the expedition, which will last about a year, is divided into two sections. The first, starting from Sourabaya, will pass through the Timor and Tenimber groups of islands to the Aroos and Ké Islands and thence to Banda or Amboina, a total distance by the route selected of about 2500 English miles. The second section, starting from Banda or Amboina, will pass between Halmaheira and Celebes through the chain of islands leading up to the Philippines, and then return to Java by the channel between Celebes and Borneo, making a traject of some 3000 miles. Looking to the advantages derived from Prof. Weber's previous experience in exploration of this nature and his well-known devotion to the subject, there can be little doubt that this expedition will result in large additions to our knowledge of the fauna, flora, and physical structure of the East Indian Archipelago.

MR. A. P. LOW, of the Geological Survey of Canada, has gone to Labrador for the purpose of studying the geological formations, and to make a map of the region. He expects to be absent for eighteen months.

THE second Huxley Lecture on "Recent Advances in Science, and their bearing on Medicine and Surgery" will be delivered at the Charing Cross Hospital Medical School on Monday, October 3, by Prof. Virchow of Berlin. It will be remembered that the first Huxley lecturer was Prof. Michael Foster, F.R.S., and that his discourse was printed in these columns. Prof. Virchow's lecture will, it is stated, be delivered in English.

THE summer session of the Institution of Mechanical Engineers will take place at Derby, commencing on Tuesday, July 26. The following papers have been offered for reading and discussion, not necessarily in the order here given:—Manufacture of aluminium articles, with description of the rolling mills and foundry at Milton, Staffordshire, by Mr. Emanuel Ristori; water softening and purification by the Archbutt-Deeley process, by Mr. Leonard Archbutt; mechanical testing of materials at the locomotive works of the Midland Railway, Derby, by Mr. W. Gadsby Peet; electric current for lighting and power on the Midland Railway, and driving direct by electric motor without shafting, by Mr. W. E. Langdon; narrow-gauge railways, 2 feet and under, by Mr. Leslie S. Robertson; results of recent practical experience with express locomotive engines, by Mr. Walter M. Smith.

THE summer meeting of the Institution of Junior Engineers will be held at Liverpool, from August 8 to 13. The president-elect of the Institution is Sir W. H. White, K.C.B., F.R.S.

THE summer assembly of the National Home-Reading Union will be held at Exeter during the last week of the present month. The inaugural address will be delivered by Sir George W. Kekewich, K.C.B., Secretary of the Education Department, who will take as his subject "The National Home-Reading Union in its Relation to Elementary Education," and short courses of lectures upon the architecture, botany, and geology of the district will be given by Mr. Francis Bond, Prof. Baldwin Brown, Mr. A. W. Clayden and Prof. Weiss. Copies of the full programme may be obtained from the office of the Union, Surrey House, Victoria Embankment.

Science announces that the Academy of Natural Sciences of Philadelphia has received from Miss Anna T. Jeanes a gift of 20,000 dollars to be invested and known as the Mary Jeanes Museum Fund, the income to be used for general museum purposes.

THE Hayden Memorial Geological Award for 1898, consisting of a bronze medal and the interest of the endowment fund, has been conferred upon Prof. Otto Martin Torell, the director of the Geological Survey of Sweden, by the Academy of Natural Sciences of Philadelphia.

THE Belgian Government, setting an example to those of larger and wealthier nations, has offered a premium of 50,000 francs to the inventor of a paste for match-heads free from yellow phosphorus, and capable of igniting upon any dry surface. The conditions under which the competition will take place have been determined by the Ministry, who have agreed that it shall be international, and remain open until January 1, 1899.

As will be seen by a reference to our advertisement columns, a prize of 500 guineas is offered by the Sulphate of Ammonia Committee for the best essay on the subject of "The Utility of Sulphate of Ammonia in Agriculture," treated from a practical and scientific point of view. All essays sent in must be written in the English language, on one side of the paper only, and bear a distinguishing motto or *nom de plume*, and reach the Chairman of the Committee not later than November 15 of the present year.

PROF. O. C. MARSH has transmitted from New Haven to the Director of the United States Geological Survey the fourth large instalment of vertebrate fossils secured in the West in 1882-92, under his direction, as palæontologist of the United States Geological Survey in charge of vertebrate palæontology. The collection, which is packed in one hundred boxes and weighs over thirteen tons, will, in accordance with law, be deposited in the National Museum. The collection includes twelve skulls and other remains of the gigantic *Ceratopsia* from the Cretaceous; various *Dinocerata* fossils from the Eocene; a series of rare specimens of *Brontotherium*, *Elotherium*, *Miohippus* and other genera from the Miocene; a very extensive collection of rhinoceros and other mammals from the Pliocene, as well as various interesting fossils from more recent deposits. Other collections at present at New Haven will be sent to Washington as soon as their scientific investigation, now in progress, has been completed.

A CIRCULAR letter on the subject of railway passenger communication has been issued by the Board of Trade to the general managers of the different railway companies, calling attention to the recently issued report of the Departmental Committee, which unhesitatingly condemns as inefficient the outside cord system of communication, and does not regard as satisfactory existing methods of communication by pulling a cord or wire passing inside the carriages. The views expressed by the Committee as to the inefficiency of the outside cord communication are fully shared by the Board of Trade, who have for years refused to approve it. It is recommended that the law should be extended so as to require the provision of means of communication on all passenger trains, irrespective of the distance run without a stop. The letter states that the Board attach great importance to the conclusions of the Committee, and that they hope the companies by whom the cord system is still used will at once take steps to substitute for it a proper means of communication, and that the companies will, as a whole, extend the provision of such a means to all passenger trains without waiting for an alteration of the law. It is to be sincerely hoped that the railway companies, to whom the suggestions contained in the letter apply, will set to work to remedy what has been, and still is, a crying evil on many lines of railway.

SOME time ago the Public Control Committee of the London County Council received from the Departmental Committee of the Home Office, which is at present considering the questions of the manufacture and supply of water gas, an inquiry as to the opinion on the subject of the Public Control Committee. This opinion has now been communicated, and is as follows: (1) That considerable danger arises from the introduction of water gas in the process of the enrichment of coal gas; (2) that non-carburetted and non-odorised water gas should not be allowed to be used under any conditions, since it is devoid of smell which would give warning of any escape of the gas; (3) that 25 per cent. should be the *maximum* amount of water gas allowed to be introduced in the enrichment of coal gas, the proportion of water gas being ascertained by determining the amount of carbonic oxide in the rich coal gas (coal gas enriched to this extent would correspond in poisonous character to the Dowson gas, which is already in use for heating purposes and for gas engines, and would exclude the use of carburetted water gas); (4) that when it is proposed to supply poisonous enriched gas to houses and the interior of buildings, a proper inspection be made of the service pipes by a responsible officer appointed by the local or other suitable authority, who should certify that the pipes are in a sound condition and that there is no escape of gas, and that the cost of such inspection be borne by the gas company.

WHAT will be, we should imagine, a boon to electrical engineers has been brought about by the Patent Office having undertaken to supply the Institution of Electrical Engineers every Monday morning with a copy of each electrical patent specification published during the preceding week. The specifications will remain on the table of the Institution for three weeks, and will then be filed.

THE banquet given to the ladies by the Leathersellers' Company at their Hall on the 13th inst. was a very brilliant affair. The life-size portrait of the ex-Master, Dr. Perkin, F.R.S., painted by Mr. Henry Grant, and placed on an easel for close inspection, which it bore well, was an interesting feature of the evening. The Master, Colonel Bevington, "thought all would agree with him that the artist had succeeded in painting a perfect likeness of the learned doctor, and as good a picture as any they already possessed." It represents Dr. Perkin giving an address to the Society of Arts.

AFTER distributing the prizes to the successful students of the Guy's Hospital Medical School on Wednesday, July 13, Mr. Arthur Balfour delivered an interesting address on the subject of the medical profession and its work. In the course of his remarks he said there was a period at which almost the only subsidiary sciences to the art of healing, the only ones of practical value, were anatomy and physiology. But all that has been changed, and at the present moment, if a man is to make progress in medical research, he must draw his inspiration not merely from those sciences which deal with the human organism immediately, but from chemistry and almost every branch—he thought he might say every branch—of physics. But while that tendency has on the one side been making itself manifest, while the interdependence of all these sciences is becoming more and more manifest, while the assistance which each can and must give to the other is becoming more and more evident, the separate sciences themselves are so rapidly accumulating facts, are growing so enormously that specialisation is necessarily and inevitably set up in every one of them, so that you have the double tendency of an interdependence between the sciences which makes it necessary for every man who would further any one of them to have some working acquaintance with many others, but at the same time you have specialisation forced upon you by the accumulation—the rapidly increasing accumulation—of facts in every one of the sciences of which he had spoken. The result of this double tendency is that you must rely more and more for your work and research upon people whose main labour is research. You cannot expect a man in the interstices of a busy life, in the interstices of a great practice, to do much towards the advancement of his science. . . . The man who would succeed in research, the man who, at all events, desires to devote himself to research, must not be asked to burden himself with other labours. He has upon his shoulders not merely what might be called the specialised work of his profession, but he must have a sympathetic and appreciative eye to everything which is going on in other departments of science, so that even where he cannot follow those other departments minutely, he knows by the instinct of genius where to pick up those new discoveries which may help his own special branch of research. For men of that kind we required further endowment. The speaker had all his life been an ardent believer in the cause which is often laughed at—the cause of the endowment of research. In that cause he most firmly believed, and he thought there was no branch of knowledge in which it may find a more useful field of application than in that of advancing medical knowledge. . . . The work of the medical practitioner is seen at once; its value can be immediately appreciated; but he who spends his life in pursuit of the secrets of nature, working in his laboratory, may very often receive no public recognition at all during his life, except from that restricted circle of experts who alone are, after all, capable of forming any valuable estimate as to his merits.

THE young male giraffe, lately received in the Zoological Society's Gardens, is of special interest as representing the Northern form of this animal in contrast to the Southern female which arrived in February 1895, but the differences between them will be much more apparent when both the specimens are adult. Although the fact of the Northern giraffe being different from the Southern form has been suggested by various authors, and several names have been given to each of them, the subject was first placed on a sound basis by Mr. W. E. de Winton in his paper "On the Existing Forms of Giraffe," read before the Zoological Society in February 1897. It was there shown most conclusively that the Northern form, to which Mr. de Winton proposes to restrict the name *Giraffa camelopardalis*, is distinguished from the Southern form by several characters, especially by the great prominence of the third frontal horn, which is barely shown in the Southern form (*Giraffa capensis*). The young giraffe from Senegal, just arrived, belongs to the Northern form, which would appear to extend all across the Sahara into North-eastern Africa. The Cape giraffe seems to be met with in suitable localities all up the east coast into British East Africa, where it is stated that both the forms occur.

REFERENCE has often been made in these columns to the importance of attention to forestry, and we are glad to notice that the Royal Scottish Arboricultural Society has published a memorandum, prepared by the Society for the consideration of the Minister of Agriculture, dealing with the subject of a Scottish model State forest. Commenting upon the memorandum, the *North British Agriculturist* says: "We require a model forest, first of all, that we may be in a position to offer to proprietors, their wood managers and foresters, a practical proof that the principles of modern economic forestry, as taught and practised in France, Germany, India, and other countries, are equally suited to our islands. The model forest is also required as a station of experiment and research into matters connected with the development and characteristics of the various species when grown in this country, such as would indicate the correct sylvicultural treatment to be applied to them, and would enable our teachers of sylviculture to base their instructions on data obtained in this country, instead of relying on figures the result of observations conducted elsewhere. Again, we want a model forest as a field of practical instruction for students. Dr. Schlich writes: 'Something more is wanted than theoretical instruction. Instruction in the field must also be provided. There must be forests which are managed on the right lines, where students find the theory of economic forestry practically illustrated.' At the present time, Edinburgh is the only place in Scotland where lectures on forestry are given; and there does not appear to be any immediate necessity for the establishment of lectureships at other centres. It is the best policy to concentrate our efforts in one place, and to leave nothing undone to improve the facilities for teaching here, rather than to dissipate our strength in attempts to sustain the machinery of instruction in several places. . . . In view of the fact that students, while attending the forestry classes in Edinburgh, are either following other courses of study at the same time, or are employed in the city, it is essential that a model forest for their practical instruction should be provided within such a distance of Edinburgh that they may be able to visit it and return on the same day, as is now done by the students who visit woods in the Lothians, Fife, and other places."

A PRELIMINARY account of the fifth international balloon ascents of June 8 last is given in *Ciel et Terre* of the 1st inst. On the whole, the undertaking met with considerable success, and the results show that an immense field is open for the meteorological and physical investigation of the upper atmosphere. The operations extended from the longitude of Paris to that of St. Petersburg, and from the latitude of the latter place to that of Rome. The three Austrian balloons travelled in the direction of Hungary, and in the *Austria*, Lieut. Hinteroiser reached the height of 4500 metres, and registered a temperature of 17°·6 F. An unmanned balloon, which left Paris in the morning, descended in Westphalia in the afternoon, having reached a height of about 16,000 metres, and recorded a temperature of minus 83° F. Of three unmanned balloons sent up by M. Teisserenc de Bort, from his observatory at Trappes, near Versailles, one travelled 160 kilometres, and registered a temperature of minus 76° at an altitude of 12,500 metres. A similar balloon from Strassburg recorded minus 58° at a height of eleven kilometres. The highest level reached by the mounted balloons was that manned by M. Berson, which left Berlin at about 2h. 30m. a.m. It travelled 160 kilometres, and reached a height of 5500 metres, but only registered a temperature of 10°·4, while another balloon, manned by Lieut. Siegsfeld, registered 17°·6 at 4500 metres. A large unmanned balloon from Paris carried for the first time one of Violle's actinometers. This instrument worked perfectly, and has furnished some interesting results, which do not, however, agree entirely with theoretical ideas. Regret is expressed that this country has as yet taken no part in the exploration.

A REPORT has been received at the Foreign Office from the acting British Consul-General at Hamburg, stating that a Bill will probably be submitted to the German Government for the construction of an inland canal passing through the provinces of the Rhine, Westphalia, Hanover, and Bevergern Elbe, to be known as the "Dortmund Rhine" Canal. The estimated cost of the canal is 6,400,000*l*.

THE Committee of the Society for the Protection of Birds has issued a circular letter urging landowners, shooting tenants and farmers to use their authority with their keepers and others to prevent the free destruction of birds on their land, and to give instructions as to what birds only may be destroyed, which, in the words of the circular, "should properly be only those birds that, from their abundance in any particular district, may do real harm."

THE geological history of the recent flora of Britain was discussed by Mr. Clement Reid in the *Annals of Botany* for August 1888; the author has now contributed further observations on this subject to the same journal for June of this year. During the past ten years much new information has been gathered, and this is summarised in a table showing the geological range of the various species of British plants which have been found in a fossil state; the chronological divisions adopted being Preglacial, Early Glacial, Interglacial, Late Glacial, and Neolithic. About one-seventh of our flowering plants are thus recorded. The orders best represented are mainly those which possess hard fruits or seeds specially adapted for dispersal, and those with deciduous leaves. Mr. Reid remarks that it is doubtful whether a single one of our flowering plants is, strictly speaking, a native of Britain. The whole flora has originated probably in other and various parts of the world. We find now merely the species stranded by successive waves of migration, which have brought together a variety of continental forms, some Arctic, some Southern, a few even American. These migrations were, in his opinion, mainly compelled by climatic changes, though other agencies have played an important part. He thinks it probable that a far larger proportion of our plants was introduced by human agency than is generally believed to have been the case.

IN all text-books, and on the latest maps of Siberia, the coasts of the Arctic Ocean are represented as a flat *tundra* soaked with water. Dr. K. Hikish points out, in an orographical sketch of North Siberia (*Memoirs* of the Russian Geographical Society, vol. xxi. "General Geography"), that this is quite incorrect. Only the Ob region is a real low depression, which attains the Arctic Ocean and ends in low flat shores. In the east of the Yenisei there are no low depressions in Siberia, with the exception of a small one at the mouth of the Lena. The northern coasts of Siberia, from the Yenisei eastwards to Bering Strait, are high, as was known from the earlier explorers, and has been confirmed lately. There are only deltas at the mouths of the Olenek, the Lena, the Yana, and the Indighirka. In the east of the Kolyma the coasts become even hilly, leaving but a narrow strip of low land along the sea beach. Hilly tracts are met with at a short distance from the shores inland.

AT a recent meeting of the Paris Biological Society, M. Courmont gave an account of some experiments he had made with anti-streptococcic serum. He immunised an ass by inoculating it with a culture of streptococci derived from a case of human erysipelas, and thus obtained a serum which rendered a rabbit perfectly immune against these streptococci. He had also isolated eleven kinds of streptococci from erysipelas or suppurating lesions in human beings, and tried the serum obtained from the ass against these. Of the eleven different streptococci seven only were influenced by the serum. Even then, if an ass be inoculated with two samples of streptococci, it is not possible to obtain a serum efficacious against all kinds of streptococci, for the various kinds of this organism are too different for one anti-streptococcic serum to overcome them all.

THE Colonial Bacteriological Institute, attached to the Cape of Good Hope Department of Agriculture, has issued its report for the year 1896. Though belated in appearance, it is a valuable document as indicating the importance of the work carried out at the Institute. Besides the elaborate experimental investigations which have been conducted on rinderpest, we note various other directions in which the activities of the staff have been engaged. For example, no less than 1039 culture tubes of a locust-destroying fungus have been forwarded to different parts of the country, and the reports received as to the efficacy of this fungus are very encouraging. In order that the best results may be obtained, it is recommended that the Veldt should be inoculated twice a year, as the cold of winter seems to act deleteriously on the fungus. Mallein and tuberculin, for the detection of glanders and consumption, are also now produced at the Institute, and arrangements were being made, when the report before us was drawn up, for the elaboration of anti-venomous serum, as well as an anti-toxin for tetanus. The staff is, the Director points out, lamentably insufficient to carry on even the work at present undertaken by the Institute, and the appeal for more assistance is certainly amply justified by the record of what has been already done by the Department.

IN the part of the *Journal* of the Asiatic Society of Bengal issued on April 14, Mr. Frank Finn, of the Indian Museum, brings to a conclusion his series of four papers entitled "Contributions to the Theory of Warning Colours and Mimicry." The paper in question deals with experiments with various birds, from a consideration of which the author draws the following conclusions: (1) That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen when wild to attack them. (2) That many, probably most species, dislike, if not intensely, at any rate in comparison with other butterflies, the "warningly-coloured" *Danainæ*, *Acræa violæ*, *Delias eucharis*, and *Papilio aristolochiæ*; of these the last being the most distasteful, and the *Danainæ* the least so. (3) That the mimics of these are at any rate relatively palatable, and that the mimicry is commonly effectual under natural conditions. (4) That each bird has to separately acquire its experience, and well remembers what it has learned. That therefore, on the whole, the theory of Wallace and Bates is supported by the facts detailed in this and the author's former papers, so far as they deal with birds (and with the one mammal used). Prof. Poulton's suggestion that animals may be forced by hunger to eat unpalatable forms is also more than confirmed, as the unpalatable forms were commonly eaten without the stimulus of actual hunger—generally without signs of dislike.

THE most recent number of *Malpighia* (Anno xii. fasc. 3, 4) contains a description by Prof. Mattirolo of the *Nuova sala Aldrovandi* founded in honour of the Italian botanist (1549–1605), in connection with the University of Bologna, and opened in December 1897. It comprises a museum, a library, and a herbarium founded on that of Aldrovandi. The account is accompanied by a portrait and a drawing of the library. In the same number is a portrait and a brief sketch of the botanical work of Zannichelli.

THE geology of the Bacau Carpathians forms the subject of an essay by Dr. W. Teisseyre (*Jahrb. der k.k. geol. Reichs.*, Bd. 47, 1898). The strata comprise various members of the Tertiary system, highly inclined, folded, inverted, and overthrust; and sundry drift and alluvial deposits. The district is noted for its oil-springs and mineral waters, and also for its salt-deposits, which occur in both Palæogene (Eocene-Oligocene) and Miocene formations.

The Agricultural Gazette of New South Wales is an admirable journal, and contains a mass of most useful articles which are not only well written, but, in many cases, carefully illustrated. It is issued monthly, and contains in each part notes on fruit, vegetable, and flower culture for the month, besides a number of articles by experts on matters of special interest to the agriculturist. Particular prominence is given to bee-farming, and, in addition to the regular bee calendar, a series of articles on "Bees, and how to manage them" is contributed by Mr. Albert Gale, and the practical and scientific staff attached to the *Gazette* now undertake to investigate bee diseases with a view to reporting on their cause, prevention and cure. The *Gazette* is written by practical men, and is intended for the use of practical men, and should prove of great value to all engaged in agricultural pursuits.

THE results of an investigation of the catalytic influence of various gases and vapours on the oxidation of phosphorus are published by Herr Centnerszwer in a recent number of the *Zeitschrift für physikalische Chemie.* The fact that the luminosity of phosphorus in air is increased by small quantities of certain gases and inhibited by others has long been known, and was in particular investigated by Thomas Graham. According to Graham, one part of turpentine in 4440 of air by volume destroys the luminosity at the ordinary temperature. At a later period Joubert finally established the fact that luminosity and oxidation go hand in hand, and that inhibited phosphorescence could be, as in the case of pure oxygen, resuscitated by a reduction of pressure. The experiments of Herr Centnerszwer have extended over a large range of organic substances. It is found that their specific influence admits of certain general conclusions. Thus it increases in a homologous series as the number of carbon atoms increases; it is approximately the same for isomers; it is increased by a double linkage of carbon atoms; it is not greatly affected by the substitution of chlorine or bromine for hydrogen, but is increased in a high degree by the replacement of hydrogen by iodine. The results have, however, not given any clear insight into the mechanism of the process by which the oxidation is suspended.

THE preparation of sodium perborate $NaBO_3 + 4H_2O$, corresponding to an oxide B_2O_5, is described by M. Tanatar in the *Zeitschrift für physikalische Chemie.* The salt is prepared by the electrolysis of a concentrated aqueous solution of sodium orthoborate, or by oxidation of sodium orthoborate by means of hydrogen peroxide. The corresponding ammonium salt, with one molecule of water, may be prepared in the same way. The perborates are described as powerful oxidising agents, but as quite stable *per se*.

THE *Engineering Magazine* sustains its reputation as one of the best illustrated and most varied in contents of the magazines devoted to trade interests. The July part has just reached us, and contains, among other items, papers on "Sea Power at the end of the Nineteenth Century," "Some Features of Indian Railways," "The Cyanide Process as applied on the Rand," "Applications of Electro-Chemistry," and "Architectural Wrought Iron Ornament." The excellence of the illustrations in the second and last-named articles call for a special word of praise.

A NEW edition—the fifth—of Prof. Schäfer's "The Essentials of Histology" has reached us from the publishers, Messrs. Longmans and Co. The book is so well known that we need do no more than call attention to the appearance of this its latest edition.

MR. H. K. LEWIS has just brought out the second edition of "Practical Organic Chemistry" by Dr. Samuel Rideal. It differs from the first issue in the addition of several organic substances which have recently been included in the schedules for various examinations, and a few other compounds which are of general interest.

NOTICES have appeared from time to time in these columns of the monthly issues of the *Journal* of the Essex Technical Laboratories, and it is now not necessary for us to do more than announce that the third volume of the work has just been published by Messrs. Durrant and Co., Chelmsford, and that it is full of information of value to farmers, horticulturists and others.

Science Progress for July contains, among other contributions, the interesting lecture on "The Fall of Meteorites in Ancient and Modern Times," which was delivered at Oxford in February last by Prof. H. A. Miers, F.R.S.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂) from South Africa, presented by Dr. Suffield; a Brown Capuchin (*Cebus fatuellus*) from South America, presented by

Mrs. Wallace; a Lion (*Felis leo*, ♂) from North Africa, presented by Mr. P. B. Vanden Byle; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by Mr. Palmer; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mrs. Chambers; two Shags (*Phalacrocorax graculus*) from Scotland, presented by The Maclaine of Lochbuie; three European Pond Tortoises (*Emys orbicularis*) from Italy, presented by Miss E. Endicott; two Axolotls (*Amblystoma tigrinum*) from Central America, presented by Mr. W. R. Temple; a Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Clyde Hinshelwood; two Common Snakes (*Tropidonotus natrix*) from Germany, presented by Mr. A. Waley; two Orang-outangs (*Simia satyrus*, ♂ ♀) from Borneo, a Squirrel Monkey (*Chrysothrix sciurea*) from Brazil, a Gentoo Penguin (*Pygosceles tæniatus*) from the Falkland Islands, a Maguari Stork (*Dissura maguari*) from South America, two Thick-billed Penguins (*Eudyptes pachyrhynchus*) from New Zealand, a Jardine's Parrot (*Pæocephalus gulielmi*) from West Africa, two —— Honey-eaters (*Ptilotis*, sp. inc.) from Australia, two Elephantine Tortoises (*Testudo elephantina*), a —— Tortoise (*Testudo*, sp. inc.) from the Aldabra Islands, deposited; five Bridled Wallabies (2 ♂, 3 ♀) from Australia, five Ruffs (*Machetes pugnax*), two Redshanks (*Totanus calidris*), two Spoonbills (*Platalea leucorodia*), European, ten Common Chameleons (*Chamæleon vulgaris*) from North Africa, purchased; a Macaque Monkey (*Macacus cynomolgus*), two Japanese Deer (*Cervus sika*, ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Comet Perrine (June 14).—The following is the ephemeris for comet Perrine for the ensuing week:—

1898.	R.A. h. m. s.	Decl. ° ′	Br.
July 21	6 38 7	+38 52·3	3·96
22	42 6	37 58·0	
23	46 4	37 2·6	
24	49 59	36 5·9	
25	53 51	35 8·1	4·67
26	57 41	34 9·1	
27	7 1 29	33 8·9	
28	7 5 16	32 7·5	

A New Form of Grating Spectroscope.—Prof. Michelson describes, in the *Astrophysical Journal* for June, a spectroscope which seems specially adapted for examining any particular line in a spectrum. The idea is that in a grating it is desirable sometimes to be able to throw a large proportion of light into very high orders of spectra—the hundredth, for example—and according to the arrangement here adopted the method seems quite simple. The problem becomes still more simple if the grating be arranged for transmission, as the grating can then be efficiently constructed if one can make a considerable number of plane-parallel plates of glass of the same thickness. Using only seven elements—that is, seven of these plates of glass arranged in step fashion—and placing them between a collimator and an observing telescope, and the collimator slit illuminated by a sodium flame, the broadening of the lines could be easily detected, and the Zeeman effect readily observed when the sodium flame was placed in a magnetic field. The resolving power of this instrument being independent of the number of glass plates, but depending only on the total thickness, the only advantage gained in using a large number of elements is that the spectra are more separated. With a few elements the spectra overlap; but this, as is pointed out, does not make much difference if effects of broadening, shifting or doubling of single lines be alone attempted. A spectroscope with twenty elements has already been in use in the Ryerson Physical Laboratory, and Prof. Michelson is now having another constructed giving greater resolving power, and sufficient for the analysis of close groups of lines.

Structure of the H and K Lines.—Mr. Jewell tells us (*Johns Hopkins University Circular* for June) that while examining a series of photographs of the solar spectrum made by Prof. Rowland in 1888 and 1889, he discovered one plate on which the shading of the H and K lines of calcium was broken up into bands or series. These bands were noticed to begin at the centre of the shaded lines and extend outward, the distance between the component lines of the series increasing as the distance from the centre increased. Further, the series were perfectly symmetrical about the centres about H and K, and the individual lines or components somewhat nebulous, while nearly all the other lines in the same region were sharp and clear. Since that date Mr. Jewell has not been able, except quite recently, to detect this peculiarity in the photographs taken by himself; but, on March 11 last, a plate was exposed to the arc spectrum of calcium (λ 4000) under somewhat special conditions, and this showed the shading broken up into series. The shading on the red side of H was quite distinctly broken up into series similar to those of the solar spectrum mentioned above. The series on the violet side was not so distinct; while the shading is better on the violet side of K than on the red side. Mr. Jewell further says that the resolution into lines is hardly perceptible close to the principal line, but is fairly distinct about three Ångström units from H. Curiously enough, the lines of the series in the arc spectrum plate are reversed; but some distance away from the central lines it is probable that they are continued as emission lines.

To obtain this negative an extremely powerful direct electric current was used, being allowed to act for a short time before the image of the poles was thrown on the slit of the spectroscope, the length of exposure being three to four seconds. In this way the calcium was highly volatilised, and the "highly heated vapour formed a much more extended atmosphere around the poles than with a weaker current; and it is also possible that the conditions throughout the larger part of the arc were more uniform than under ordinary circumstances." Mr. Jewell thinks that, in the case of the solar spectrum referred to, the slit of the spectroscope probably covered a region of the sun's atmosphere where the principal layer of the calcium was of a particular density, and being thus to a degree isolated was able to produce its characteristic series. This, he says, is somewhat confirmed in that the general shading of H and K on the plate is unusually weak.

Blurring Aberration in the Telescope.—In the note which previously appeared in this column (May 26, p. 88), we referred to Mr. Collins' paper on this subject, and remarked that the tilting of the image not only occurs in the case of the reflector, but in that of the refractor also; the effect in the latter case being twice as great as that in the former. We should, however, have made it clearer if we had stated that the tilt is really the same in both instruments of like angular aperture, but the difference in the inequality of size of the images formed from the "marginal" and "central" portions of aperture focussed on a single focal plane is twice as great in the ordinary refractor as with the reflector. The images formed from the central portion of the reflector are smaller than those formed by the marginal rays, while with the refractor the marginal rays produce smaller images than the central rays passing through the lens.

THE LIFE-HISTORY OF THE SALMON.[1]

The investigations recorded at length in this Report are partly of biological, partly of more purely physiological interest. They were undertaken with the following objects:—

(1) To elucidate some of the factors governing the migration of the salmon, and to study the course of these migrations.

(2) To determine whether or not Miescher is right in his contention that salmon do not feed during their sojourn in fresh water.

(3) If salmon while in the river do not procure an abundance of food, to investigate from what source they obtain the energy for the large amount of muscular work they perform, and whence comes the material to build up the enormous genitalia which are developed before spawning. Such an investigation must necessarily yield information of interest as to the chemical changes of various substances in the animal body.

[1] "Report of Investigations on the Life-History of the Salmon in Fresh Water." From the Research Laboratory of the Royal College of Physicians of Edinburgh. Edited by D. Noël Paton, M.D., Superintendent of the Laboratory. A Report to the Scottish Fishery Board presented to Parliament by command of Her Majesty. (John Menzies and Co., Edinburgh)

The method employed was as follows. From the constant stream of salmon setting from sea to river specimen fish were taken (1) from the estuaries just as the fish were leaving the sea, and (2) from the upper reaches of the river. The rivers selected were the Spey, Dee and Helmsdale. Fish were taken from these stations at three periods: (1) in May and June; (2) in July and August; (3) in October and November.

By comparison of the fish from the upper waters with those just leaving the sea the nature and extent of the changes during the passage of the fish up the rivers were determined. The method may be compared to that of taking samples of the water of a river from two points in order to determine the changes between these points.

In the course of these investigations results obtained from salmon of very different sizes had to be compared, and therefore all weighings, &c., were expressed in terms of a fish of uniform length—the standard fish. The length selected was 100 cm.

The number of fish examined was 104, a number small as compared with the myriads of fish which ascend the rivers. It was considered necessary to investigate how far these fish were fair average specimens of their classes. Mr. Archer's extensive series of measurements and weighings of salmon from various stations enabled him to ascertain that the female fish examined by us were really average specimens, but that the small number of male fish with which we had to deal were not so typical. It is from observations on female fish that our conclusions are drawn.

The first question dealt with was the evidence as to whether salmon feed in fresh water. Dr. Gulland shows that the salmon coming from the sea early in the summer has the stomach lined with a perfectly developed mucous membrane, while in the intestine the mucous membrane is somewhat degenerated. In fish taken from the upper waters the mucous membrane of stomach and intestine are intensely degenerated. In kelts—spawned fish passing back to the sea—there is a regeneration of the mucous membrane.

Dr. Gillespie has investigated the activity of the digestive secretions by preparing in the usual manner glycerin extracts of the mucous membrane of the stomach and intestine. He finds in every case a very low digestive power. From this he concludes that the fish even when approaching to the river mouth have practically ceased to feed.

His further studies of the bacteriology of the alimentary canal show that, while in all situations, as might have been expected, the number of bacteria varies directly with the temperature of the water, in fish from the upper water there is usually a larger number of bacteria, and more especially a larger number of putrefactive bacteria than in fish from the estuaries. From this he concludes that the secretion of acid must be in abeyance in the former.

These investigations, taken with the evidence adduced by Miescher, seem to leave no doubt that the salmon does not *digest* and *use* food during its sojourn in fresh water.

It is because of this prolonged fast, and because of the important changes going on in the fish during the fast, that so interesting a physiological study in metabolism is afforded. An opportunity is offered of investigating the manner in which materials are stored in the animal body, the extent to which they may be transferred from one organ to another, the nature of some of the chemical changes they undergo, and the extent to which the various stored materials are utilised as a source of energy.

Evidence is adduced to show that the fish taken in the upper waters in May and June may have entered the river earlier in the year, and it is therefore not considered fair to compare them with the estuary fish of that period. On the other hand, there is evidence that the fish leaving the sea from May to August go to the upper waters, and hence the upper water fish of July and August are compared with the estuary fish of May to August. Evidence is also presented to show that the fish leaving the sea in October and November do not pass to the upper reaches during these months. Hence the upper water fish of October and November are to be compared with the estuary fish of May to August.

Adopting this method of comparison, the following results have been obtained.

Solids and Water of Muscle, Ovaries, &c.—It is shown that during the sojourn of the fish in fresh water there is a steady loss of solids from the muscles and a steady gain of solids by the genitalia, and that the gain of solids by the genitalia is small compared with the loss of solids from the muscle, that in fact the greater part of the solids lost from the muscles are used for some other purpose than the building up of the genitalia.

Fats of Muscle, Ovaries, &c.—Nothing is more extraordinary than the enormous accumulation of fats which takes place in the muscle of the salmon during its visit to the sea. Not only is the tissue between the individual fibres loaded with fat, but, as shown by Mr. Mahalanobis, an intrafibrous and interfibrillar accumulation of fat occurs. In the river, as the season advances, this accumulated fat steadily disappears from the muscle. There is no reason to suppose that anything of the nature of a degeneration occurs. The fat is simply excreted from the muscle to supply the fat of the growing genitalia, or used in the muscle as a source of energy.

In the muscles the fatty acids are chiefly in the form of ordinary fats. In the ovaries and testes, on the other hand, the fatty acids are largely combined with phosphorus as lecithin. An important decomposition and reconstruction of the fats thus occurs in the growing ovaries. In the ovaries the amount of lecithin is very large, while the amount in the testes is by no means trifling, and the constant occurrence of this substance seems to point to it as the first stage in the formation of nucleins.

Proteids of Muscle, Ovaries, &c.—Dr. Boyd's observations indicate that the albuminous materials of the muscle may be divided into two classes: (1) those soluble in salt solution; (2) those not soluble in salt solution. He shows that globulin substances constitute nearly the whole of the soluble proteids, and that proteoses and peptones are not present in any circumstances. He further shows that there is a small quantity of some phosphorus-containing proteid—either a nuclein or a pseudo-nuclein—among the soluble proteids. It is these soluble proteids which diminish in fish in fresh water. When they are abundant, as in fish at the mouth of the river, on boiling they may coagulate between the flakes of the muscle, and form with the fats the characteristic *curd*.

Of the insoluble proteids, part is composed of white fibrous tissue, part of a phosphorus-containing proteid which may be called myostromin.

Dr. Dunlop's results show more fully the extent to which proteids accumulate in the muscles, and the rate at which they diminish as the fish passes up the river. The first point of interest is that the proteids do not disappear to anything like the same extent or at the same rate as the fats. The second point of interest is that the proteid surplus available for energy—that is, the proteid not used in building the ovaries—is no greater in the upper water fish in October and November than in July and August. This seems to indicate that quite early in the season, while the ovaries are growing slowly, the proteids disappearing from the muscle are more than sufficient to meet the requirements of these structures; while later in the year, when the growth of the ovaries is going on more rapidly, all the proteid disappearing from the muscle is transported to and used in them.

Phosphorus of Muscle, Ovaries, &c.—It is shown that in the female fish only just enough phosphorus is accumulated in the muscle to supply the wants of the growing ovaries, while in the male the accumulation is superabundant. In this connection it is further pointed out that in the male the enormous growth of the bony jaw may use up a further amount of phosphorus. Whether in the female any phosphorus required for the ovaries in excess of that stored in the muscle is procured from the bones, these observations do not indicate.

The phosphorus is stored in the muscle chiefly as phosphates, and to a somewhat smaller extent as lecithin. The amount of lecithin in the muscle is not nearly sufficient to yield the lecithin of the ovaries. In the ovaries the phosphorus is largely in the form of ichthulin, a pseudo-nuclein, so the phosphorus from the phosphates of the muscles must undergo profound changes in the growing ovaries, and being synthesised with organic bodies be built into these compounds. That these compounds are the forerunners of the still more complex nucleins of the embryo is indicated. In the male the transference of the phosphates of the muscle into these higher nuclein compounds is even more direct, and the occurrence of lecithin in considerable amount in the growing testes seems to point to this substance as the first step in the synthesis of inorganic phosphates to nucleic acid.

Iron of Muscle and Ovaries.—Dr. Greig has shown that the ichthulin of the ovaries contains iron, and the amount of iron in the ovaries thus increases as the organs grow. Whence is this iron procured? It has been shown that the iron lost from the muscle is insufficient to yield the iron gained by the ovaries, and it is thus probable that the hæmoglobin of the blood must be drawn on for this element. The liver does not seem to yield iron to the ovaries.

Pigments of Muscle, Ovaries, &c.—Miss Newbigin's study of the pigments of the muscle and ovaries show that two lipochromes are present. First, the very widely distributed yellow pigment, lutein; and second, a bright red lipochrome, which, mixed with the former, gives the characteristic colour to the salmon muscle and ovaries.

Though it has not been possible to investigate the source of the pigments, the evidence adduced tends to show that the characteristic red pigment is probably not derived from the food, but that it is constructed possibly out of the very widely distributed yellow pigment. Its storage in the muscles and its transference to the ovaries is demonstrated. Its fate in the male fish is still obscure, though the deeper pigmentation of the skin in the male suggests its elimination by that channel. What the purpose of the pigment is, is not clearly indicated, though it seems probable that by colouring the ova it may assist in their concealment during development.

Nature of the Transference of Material.—These observations throw important light on the nature of the transference of material. They clearly show that nothing of the nature of a degeneration in the muscle takes place. The muscles simply excrete or give out the material accumulated in them, or utilise it as a source of energy within themselves.

Source of the Energy for Muscular Work, &c.—The extent to which the fats and proteids lost from the muscles are used for the construction of the genitalia on the one hand, and for the liberation of energy on the other, varies somewhat in males and females. Taking the earlier months—to August, it is shown that in the female 12 per cent. of the fats and 3 per cent. of the proteids go to the ovaries, the rest being available for energy; while in the male about 5 per cent. of the fats and 14 per cent. of the proteids go to the testes.

The total energy liberated from fats and proteids is possibly somewhat greater in the male than in the female, being to August 1,271,000 kgms. per fish of standard length in the female, and 1,380,000 kgms. in the male. Of the energy thus liberated about 2200 kgms. are required to raise the fish to the height of the upper water of the river, the remainder being available for the much greater work of overcoming the resistance of the stream, and for internal work and for other calls upon the energy supply.

Of this total available energy in the female, about 20 per cent. is derived from the proteids, while in the male only 9 per cent. is derived from this source. The rest is derived from the fats.

Food Value of Salmon.—The food value per unit of weight of muscle deteriorates as the season advances. In each fish caught in the estuaries the food value remains almost constant, the larger size of the late-coming fish making up for the deterioration of the flesh. The food value of each fish caught in the upper waters is less than that of those caught in the estuaries, and in October and November is only about one-third that of fish caught in the river-mouth. Since the large late-coming fish contain more ova than the smaller fish, their destruction does more damage to the breeding stock.

Factors Determining Migration.—In considering the question of migration, it must be remembered that the Salmonidæ are probably originally fresh-water fish, and that the majority of the family spend their whole life in fresh water. Salmo Salar and other allied species have apparently acquired the habit of quitting their fresh-water home for the sea in search of food, just as the frog leaves the water for the same purpose. When, on the rich marine-feeding grounds, as great a store of nourishment as the body can carry has been accumulated, the fish returns to its native fresh water, and there performs its reproductive act.

That the passage of the fish to fresh water is not governed by the growth of genitalia and by the *nisus generativus*, is shown by the fact that salmon are ascending the rivers throughout the whole year with their genitalia in all stages of development.

From May to August the fish leaving the sea have about the same amount of material stored in their muscles. During these months the ovaries are yet small, and do not act as a reservoir for stored material. In October and November the estuary fish have a smaller amount of stored material in their muscles, since the period of rapid growth of the genitalia has supervened before the full accumulation of material in the muscles has been accomplished. This rapid growth of the genitalia would withdraw material, and prevent its accumulating in the muscle; and thus, when the necessary amount of stored material was accumulated, it would be distributed between these structures. The late-coming salmon, although the supply of solids in the muscles is smaller, have the ovaries so large that the total store of nutrient material in the fish is just about the same as in those entering the estuaries in the earlier months.

The state of nutrition is the factor determining migration towards the river. When the salmon has accumulated the necessary supply of material, it tends to return to its original habitat.

THE STRAMBERG CORALS.[1]

PROGRESS in the classification of corals has been a passage from fog to fog across lucid intervals cleared by successive systems, which have collapsed under the efforts to improve them. The primæval darkness of Ellis, Guettard and Esper was first lightened in 1830 by the classification of de Blainville, which was obsolete within four years of its publication. A long series of memoirs by Edwards and Haime, begun in 1848, gradually laid the foundations of a system at once more adequate to the wide variations in coral structure, and more natural; but it was not until 1857–60 that the two authors' complete classification was published in the great "Histoire Naturelle des Coralliaires." The essential features of their scheme were the separation of the Palæozoic corals as the order Rugosa, and the division of the later corals into two orders, the Aporosa and Perforata, characterised respectively by a solid and a porous wall. The classification gave helpful guidance to those who chose to use it; but many authors preferred to follow de Fromentel, who in 1861 issued a more artificial but simpler system, based on the mode of association of individual corallites into compound coralla. The life of Fromentel's classification was, from its nature, necessarily brief; while that of Edwards and Haime was weak in so many points, that under the numerous amendments of Étallon, Milaschewitsch, von Zittel, and others, the original boundaries became indefinite, and the system once more involved in fog. In 1884, P. M. Duncan restored order by a revision of the genera of Neozoic corals; he adopted, in the main, the same principles as Edwards and Haime, and his revision is still the most useful handbook to coral classification. It has held this position in spite of repeated attempts to change the whole basis of classification. Thus Pratz in 1882 proposed a scheme founded on the septa; von Heider and Ortmann have advocated another, resting on the formation of the "wall"; and recently Miss Ogilvie has suggested a new arrangement, even more radical in its changes.

Miss Ogilvie's views are propounded in two great papers: one in the *Philosophical Transactions*, in which the general principles are stated; and the second, a monograph of the Stramberg Corals, in which her theories are applied in practice. The former work is already known to readers of NATURE by an explanation written by the authoress (vol. lv. p. 280, January 21, 1897), so that the general principles need not be considered here. It has been found in coral history that the best test of a theory of classification is its results. Students of the corals have always been ready to welcome any morphological light that offered guidance through the taxonomic gloom, and have preferred to judge it by the help given in practical work. We therefore turn to Miss Ogilvie's monograph to see whether her classification associates similar corals, and separates those which are unlike.

The authoress is to be congratulated on her material. The Stramberg Schichten have yielded an instructive fauna, different sections of which have been described in other parts of this work by von Zittel, Cotteau, Böhm, Moericke and Zeise. The beds occur on the boundary between the Cretaceous and Jurassic systems, and their fossils have the usual interest of a transition fauna. Miss Ogilvie has described the corals in detail and with care, and her monograph is illustrated by twelve fine large plates. It is unquestionably a most valuable and extensive addition to our knowledge of the Mesozoic corals,

[1] "Die Korallen der Stramberger Schichten," by Maria M. Ogilvie, D.Sc., Palæontologische Studien über die Grenzschichten der Jura- und Kreide-Formation im Gebiete der Karpathen, Alpen und Apenninen. Part vii. Palæontographica Supplement, vol. iii. pp. 73–282, pls. vii.–xviii. (1897).

and is well worthy of a place in the series in which it is published.

The monograph has, therefore, a double interest. It makes known to us an important coral fauna, and the descriptions are arranged on a scheme which has all the attractiveness of daring and revolutionary change. The authoress distributes the Stramberg corals among 128 species and 41 genera, which are grouped into nine families. And it is by the constitution of these families that Miss Ogilvie's classification will be judged.

The first family is the Amphiastræidæ, of which the typical genus *Amphiastræa* was founded by Étallon for a Kimmeridgian coral that presents some points of resemblance to the Rugosa. Koby has described a series of Jurassic genera allied to *Amphiastræa*. He placed them in the Rugosa, but made no attempt to formulate a definite family for their reception. Miss Ogilvie has now taken this step, which will probably receive unanimous approval, although whether all the eleven genera are correctly assigned to it is open to doubt. Let us take, for example, the genus *Dendrogyra*, of which the type species is the recent West Indian coral *D. cylindrus*, Ehr. We fail to see in that coral any of the primitive characters of *Amphiastræa*. *Dendrogyra* has a columella, and the corallites are separated by bands of exotheca. The new species which Miss Ogilvie refers to *Dendrogyra* has no exotheca separating the corallites, and there is no columella shown in the figures (Pl. xvi. Fig. 3, 3*a*, 4, 4*a*), although "eine Art von Saulchen" is mentioned in the description. Miss Ogilvie remarks the near affinity of *Dendrogyra* and *Euphyllia*; and if those genera be closely related to her *D. sinuosa*, then we can only conclude that the fossil is no special ally of *Amphiastræa*.

The next family is the Turbinolidæ, represented by the genera *Epismilia* and *Pleurosmilia*. Of the former Miss Ogilvie has seen six Stramberg specimens, which are referred to three species. Both the genera are transferred to the Turbinolidæ from the very original view, that a diminished development of endotheca goes on *pari passu* with a stronger development of "wall." Miss Ogilvie retains throughout von Heider's terms Eutheca and Pseudotheca, and this family illustrates the difficulties they occasion; thus it is stated (p. 134) that the subfamily Trochosmilinæ have "æchte theca vorhanden," whereas *Epismilia*, the second genus placed in it, is stated (p. 141) to have a "Pseudotheka." The retention of *Epismilia* is a step of doubtful value, for there seems good reason to regard the genus as founded only on a worn, weathered *Montlivaltia*. But according to Miss Ogilvie's scheme *Epismilia* and *Montlivaltia* are placed far apart, and separated, in fact, by four families. One of the intermediate families is the Pocilloporidæ, the most novel feature in which is the inclusion there of the genus *Stephanocœnia*. *Pocillopora* has well developed tabuli, rudimentary septa, no pali, and massive cœnenchyma. *Stephanocœnia*, on the other hand, has no tabuli, well-developed septa, exceptionally distinct pali, and there is often no cœnenchyma or exotheca between the corallites. Miss Ogilvie may perhaps be using the name *Stephanocœnia* in some new sense; for she elsewhere remarks, "it is doubtful whether they [*Astrocœnia* and *Stephanocœnia*] are represented in recent seas" (*Phil. Trans.*, vol. 187, p. 307). But *Stephanocœnia* was founded on the common living West Indian coral *S. intersepta*.

The next family is the Madreporidæ represented only by *Thamnaræa*. In the corals of that genus the septa are palisades of irregular, separate, vertical rods, connected by horizontal, synapticular platforms. Miss Ogilvie describes the septa of Madreporidæ as "bilaterally or radially arranged, compact; sometimes represented by a series of horizontal spines projecting inwards from the wall." If *Thamnaræa* is to be retained in the Madreporidæ the family characters must be changed. *Thamnaræa* appears to represent one of the extreme types of the septal structure seen in the genus *Microsolena*, which Miss Ogilvie leaves in the Fungidæ. To separate *Thamnaræa* from *Microsolena*, and ally it to the compact-septumed *Madrepora* is one of the changes which prejudices the principles upon which the proposal is based.

It may be objected that these criticisms are mere details. But it is by such details that works as the present can best be tested. There is no need here to rediscuss the principles, as that has been previously done by Bourne and Bernard. The value of the present work is that it gives us a chance of examining the results to which the principles lead. Although the results may not all be accepted, students of the Madreporaria will be grateful to Miss Ogilvie for this solid addition to the mass of knowledge of Mesozoic corals. Her reshuffling of the genera is useful and suggestive, for it brings together corals usually placed at the opposite ends of the group, and renders necessary the close comparison of genera which otherwise no one would have thought of comparing. Thus the work is of value not only as the description of many new and interesting corals, but as it leads to the re-examination of forms previously known from a fresh point of view, a labour which is always profitable.

J. W. GREGORY.

UNIVERSITY EDUCATION.[1]

THE Johns Hopkins University, which has done me the honour to ask me to say a few words on this occasion, is, although already distinguished, a new and young university. I can remember well its beginning, and as Dr. Gilman has hinted, I may claim to have taken some small part in its birth. When I moved in 1870 from London to Cambridge, I took with me a bright lad of whose ability and industry I had already taken notice. At Cambridge he became my right-hand man, and I had some hopes that I should long have his help; but President Gilman appeared upon the scene, and his influence was so strong that I felt that my own interests were not to be considered, and that I ought to send that favourite across the waters to occupy the first chair of Biology in this new university. Although the memories of him whom I need scarcely name, Henry Newell Martin, are tinged with melancholy, still I feel that this university must always look back with pride and affection on the work which he has done in this country, and in this affection and pride I claim a small share for myself.

Your university is a new one. I come from a very old one; one which was founded six hundred years ago, which has lived through all those centuries, and which, though it has some of the charms, has also some of the evils of antiquity. The traditions of the past weigh heavy upon us. When we attempt to stretch our limbs to meet the new needs of new times we find some old written law, some well-established prejudice, some vested interest preventing our full development. You are a new university; and although I have purposely refrained from refreshing my mind as to the exact status of your regulations, and as to how far you may have already entangled yourselves in the toils of enactments, still I will take it for granted that you differ from us in the freedom with which you can move forward towards the needs of the coming times; and I think perhaps I could not do better at the present moment than to use the opportunity offered me to take my old university as a text, and to draw from it and its history some few plain reflections which I hope may be practical and useful with regard to the conduct of universities. Allthough I understand that I have been especially invited by the medical faculty, I will take leave to treat only of general things, since the welfare of the medical faculty is bound up in that of the whole university.

The morphologists tell us we can learn much by studying the embryo, and something perhaps may be learned by looking back at this old University of Cambridge in the days of long ago—in the days when it too was a relatively young university. Things were very different then from what they are now. The dimly lighted streets or alleys in which the students lived were an emblem of the whole university. There was little outward show of glory then; there were no beautiful buildings, few books, and each student's duty was, in part, to listen to the lecture, to the reading of something which was written, but which he could not see with his own eyes. In spite of all these difficulties there were certain features of the university of that time which I trust I may say have been, with some little wavering here and there, maintained since, and which I cannot help thinking have contributed in very large measure to make it what I may venture to call it, a famous and great university.

One of the most striking features of the attitude of both students and teachers at that early time was that they recognised in the training of the university a preparation for practical life. There were at that time three main occupations in which learning was of practical use; and in correspondence to those three occupations there were established the three great faculties of the

[1] Address delivered at the Johns Hopkins University, Baltimore, October 11, 1897, by Dr. Michael Foster, Sec.R.S. (Reprinted from the *Bulletin* of the Johns Hopkins Hospital April.

university—the faculty of theology, the faculty of law, and the faculty of medicine. And, if one reads what those men of old wrote concerning what they thought ought to be done in the university, one is very much impressed by the conviction which they had that the teaching should be an earnest preparation for practical life. If it soon became necessary to establish a fourth faculty, the faculty of arts, that was simply as a faculty preparatory to the others, as one supplying the first steps for and leading up towards the knowledge which should be of use in practical life; and it is worth noting that although they called that faculty the faculty of arts, and although the acquisition of the Latin language was one of the chief studies of that faculty, necessarily so because all the instruction which could be given was given in that tongue, among what they called the arts were the beginnings of the kind of knowledge which we now call science.

Another feature of the university life of those early times was the very strong feeling that the work of the university consisted not in the mere acquisition of knowledge, but in the training of the mind. The amount of knowledge which they had for distribution was very limited; but they used that small stock of knowledge to the very best of their ability, as the means of awakening the minds of the students and training them for thinking and arriving at conclusions. This is seen even in what they called at that time examinations, though the word then had a very different meaning from what it has now; there were then no written examinations, there was not that demand on paper so characteristic of modern times, and that great necessity of modern civilisation, the waste-paper basket, was unknown. The examiners went quietly to work to ascertain in the most sure way whether a student had profited by what he had listened to. Instead of having two examiners for some hundreds of students, they appointed nine to each student; and these went in with him and out with him until they satisfied themselves that he knew something, and had gathered something from what had been told him. And then as a final test they put him on the "stool" and made him debate in public, the test being used in such a way as to bring out his stock of knowledge, and especially his power of using it and of showing that his mind had been trained at the same time that he had gathered in a certain number of facts.

There was another feature of the university which we sometimes find it difficult to realise: the spirit of inquiry was rife among them. At that time the ways of thinking were devious; but still within the limited circle in which they moved, along the only lines then open to them, the thinkers used their minds in the spirit of free inquiry. When one reflects upon the circumstances in which they worked, one cannot help realising that their long-drawn-out discussions were at bottom an expression of the love of inquiry, and that if they had had the advantages which we enjoy now, that which we call their subtlety would have broken out into discovery and invention.

Lastly, it was a feature of the university at that time that it was willing to take into its bosom any one who showed that he had any promise of benefiting by the instruction there given. It was an open home for all who wished for learning.

These are some of the features of the University of Cambridge in the olden times; and may we not, using them as a text, attempt to draw some conclusions as to what are the proper and essential functions of a university, and what ought to be some of its guiding principles? As I said just now, the knowledge which they possessed was extremely limited, the facts with which they had to deal were very few. What can we say of knowledge at the present time? May we not say, if theirs was too little for them, ours threatens to be too great for us; that we are entering upon an age in which the facts which have to be learned, and the various kinds of knowledge which have to be acquired are becoming too many for us? It is, or it may be perfectly true that one of the advantages of learning is that it enables the learner to learn more rapidly; but is not this true, notwithstanding that the increment of knowledge is increasing far more rapidly than the increment of the power to learn? Is it not a serious matter for consideration that the things that the university has to teach are rapidly becoming far too numerous for the learner to learn? Is it not true that we cannot do now as they did in those old times, teach the student all that was known? We are compelled to make a choice, we must teach to the student some things and omit to teach him others. That is a necessity which it seems to me is increasing as the years go on. Nevertheless that position is a cruel one; for it may be truly said that every kind of knowledge has a value of its own; each kind of knowledge has for the learner a value which can be given by no other kind, and he who fails to gain any one kind of knowledge is thereby a loser. For building up the student into the full and complete man, the best course would be to take in all the knowledge which can be offered by a university; but, as I said just now, a choice must be made, and the consideration of the principles which should guide the decision as to what should be chosen and what should be left, demands the most serious attention. Here I think we may venture to follow the example of the old university. Admitting that each kind of knowledge is particularly fitting for a particular calling, that for every particular calling in life there is a knowledge, or there are kinds of knowledge which are suited or fitted for that calling, and without which that calling can not be pursued with success, in the necessary choice which must be made between this study and that, is it not a wise course to take that which best serves the future calling of the student? I cannot but think that in this choice of which I am speaking, the arguments for what are sometimes called technical education are unanswerable; that one of the principles of most importance in determining the choice of the studies to be taken up by the student lies in the fitness of the study for giving him power in the calling which he proposes to adopt. We must, however, remember that the knowledge which is thus to be imparted to him must be not merely a knowledge of facts, but bring with it the power of thinking. If technical education is understood in this way, not as a mere accumulation of facts, not as the mere heaping of knowledge, but as the training of the mind in some particular kind of knowledge, the dangers, I venture to say, which some fear, will prove unreal, and it will be seen to be a true principle of university education.

There is another aspect in which we may look at university duties. May we not say that the tendency of modern civilisation is to smooth down individual differences, and that the whole tendency of the environment of man is to make each man increasingly more like his brother? There was a time when one could tell by the dress where a man came from; but this has become less and less easy, and it is not in dress alone, but in his very nature that man all over the world becomes more like his fellows. I myself during the short time I have been in this country have felt it more and more difficult to tell what are the differences between an American and an Englishman, and I trust that these differences are equally difficult to you. This may be a favourable aspect, but there is an unfavourable side to this continual influence of things about us. Mr. Francis Galton has shown that there is a great tendency in things to make men more and more alike in stature, and there seems a corresponding tendency to make men all alike in the stature of their minds. We seem tending in many ways to a monotonous mediocrity of intellect. This influence is especially strong among young people. I see for myself in the University of Cambridge that when one young man does one thing they all do it; they go astray like sheep, and they also go straight like sheep. Surely it ought to be a function of the university to counteract this tendency, and so to bring the influences of learning upon the young as to develop individual differences. That I take it is one of the most important functions which a university can exercise, but one which is not always kept in view in university enactments. Here I can speak of my own university, and in doing so can lay the blame for the present condition of things on the traditions of the past. I find in my own university discouragement for the development of individual power. Every lad who comes to the University of Cambridge is compelled to pass through the same examination, to know the same things to the same extent, whatever may be the nature of his mind. He must know a little Latin, a little Greek, a little mathematics, a little history and one or two other subjects. Each one who comes, whatever his previous history, must pass through this one gate; the whole university has been pushed through this one common gate. Now I know that this may be defended; it may be said, for instance, that it is a bad thing not to know Latin. I quite agree with that. I think it a very bad thing not to know Latin, but I also think it a very bad thing for a lad to be thrown into life, it may be to go through life, without any clear idea whatever of the fundamental laws which govern the phenomena of living things. It may be said that it is a bad thing not to know Greek; I agree with that. Not to know Greek is to my mind worse than not to know Latin, but I think also that it is a bad thing for a lad to go through life ignorant of the fundamental laws of chemical action. If you go along in that line of argument, you end by compelling a lad to know everything before he enters the university. If I had my way, and could wipe out the traditions of the past, I should vary that entrance examination. I should hold on to the old tradition of the university that it was ready to receive everybody who was likely to profit by its instructions. I should make the examination look, not backward as it does now, but forward, and should only insist that the lad must give such proofs of intelligence and industry as to lead to the hope that the years of university life would not be spent in vain. When the lad has really entered the university (at times he does not do so until he has spent two or even three years at the place in preparation, and sometimes goes away from the place without having really been admitted), it seems to me there should be a still wider scope for his studies. He has even now, it is true, an opportunity to take a degree in one or other of several branches of learning, but in each case he must follow out a particular schedule which has been laid down, and which compels him to walk along a particular path and no other. If he wishes, for example, to study mathematics with philosophy, he would find that he could not do so, for in the examinations mathematicians have nothing to do with philosophy, and philosophy nothing to do with mathematics; and so in other things. I venture to think that this is not a satisfactory condition of things, and that throughout the whole academic course there should be a freedom of the young mind to develop in the line in which it was intended to develop. When I urge this upon my friends, they all say "It is very good, but it is impossible; the examination machinery would become so complicated as to break down." But I would ask the question, Are examinations all in all? Were the examinations made for universities, or were universities made for examinations? I myself have no doubt about the answer. I trust that this new university, which can walk with freedom along new lines, will find some way of so arranging studies and examinations that the two will not conflict, and that anybody coming here will find that the particular gifts that have been given to him, and which it was intended should be developed, will meet their fullest expansion.

Lastly, there was another feature which the old university possessed and which I may also call an essential feature of a university, that is, the spirit of inquiry. No university can prosper as a university that not only does its best to favour special inquiries when these are started within it, but also in the whole course of its teaching develops, or strives to develop the spirit of inquiry. Now here again I fear that examinations—such at all events is my experience—are antagonistic to inquiry; and I would suggest that in arranging examinations one ought always to look ahead to see how far one can possibly order those examinations so as to favour the teaching which teaches in the real and true way, teaching by regarding each bit of learning as in itself an act of inquiry, and so as to favour in the highest degree actual inquiry when it is taken in hand. This of course is antagonistic to one function of examinations, namely, that of putting young men to compete against each other. You cannot so judge inquiries as to put the inquirers in any class list or in any order; the most you can do is to give an inquiry the stamp of approval of the university, a testimony that the inquiry has been carried out in a satisfactory way. It is true that in this way you lose that which is sometimes thought to be of great value, emulation between the scholars; but if you take away that kind of emulation you substitute for it another one far more strong and effective, that emulation that comes of striving with nature. I take it that the good which is done to a lad in starting him upon an inquiry is infinitely greater than any which can be gained by competition with his fellow students. Here I am glad to say a good word for my own university; for we have in a very quiet way, and unobserved, secured the adoption of an enactment which allows a lad to enter the university and obtain his degree and all which follows upon that without entering into a single examination. At the present moment it is possible for one, it is true under exceptional circumstances, to come to the University of Cambridge in England, and if he convinces a competent body of judges that he is a person likely to carry on inquiry in a successful manner he can enter the university as a student, and if he satisfies another body of men after a time that his inquiries have resulted in a real contribution to knowledge he can secure his degree. He can get that without ever having touched a written examination paper, and I am proud that we are able to offer that to the world; for it has happened again and again that a man who had real genius for a particular line of inquiry stumbled over the preliminary studies of which I have spoken, knocked at the door of our university in vain and was sent away. Now such an one would be admitted, and I venture to say that in the long run the university will be the gainer.

These, then, are some few thoughts concerning universities and their methods. I say I have purposely learned nothing about your enactments, but from what I know of your short past I feel confident that this university will in the future be conspicuous for progress. May I hope that it will carry on education along some of the lines which I have indicated to-day, and perhaps some day we in the old country may mend our ways after your pattern.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Calendar of the Glasgow and West of Scotland Technical College for the Session 1898-99 has just been issued.

DR. R. A. HARPER, of Lake Forest University, has been appointed to succeed Prof. C. R. Barnes in the chair of Botany in the University of Wisconsin.

MR. H. R. M. BORLAND has been appointed junior assistant in the chemical and metallurgical department of the Bristol Merchant Venturers' Technical College.

MR. HERBERT BOLTON, who for the last eight years has held the post of assistant keeper in the Manchester Museum, has just been appointed to the curatorship of the Bristol Museum.

WE learn from the *American Naturalist* that Miss Phœbe Hearst has given a building for the School of Mines to the University of California. The building will be fully equipped at her expense.

PFEIFFER scholarships in science have been awarded, in connection with the Bedford College for Women, London, to Winifred E. Watts and Margaret Foster. The Reid fellowship, tenable at Bedford College, has been awarded to Margaret Lyal Dale.

DR. CHARLES HUNTER STEWART, who for the past ten years has acted as chief assistant in the Bacteriological Laboratory connected with the chair of Medical Jurisprudence and Public Health in Edinburgh University, has been appointed to the new professorship of Public Health and Sanitary Science at Edinburgh University.

THE Science and Art Directory (revised to June 1898) has just reached us from the Department of Science and Art. In it is to be found, as usual, full information as to the regulations for establishing and conducting science and art schools and classes. Several minor alterations have been made in the regulations, and attention is called to these by the use of italic type.

SCIENTIFIC SERIALS.

Memoirs of the Novorossian (Odessa) Society of Naturalists, vol. xx.—On the origin of *limans* in the Government of Kherson, by M. Rudski. A "liman" is the local name for small bays on the sea-coast which are now separated from the sea by a bar, and offer very interesting peculiarities of structure and fauna. Various hypotheses having been made as to their modes of formation; these hypotheses are discussed, and new observations on the oscillations of the limans are given.—Notes on an excursion to Crimea, by the same. Chiefly on the geological changes going on in the coast-line.—Note on the meteorite of Savchinskoye, by R. Prendel (with a photograph of it).—Geological description of the Odessa district, by Prof. Sintsoff. A great deal of attention is paid to the hydrology of the region, and especially to the *limans* (with a geological map).—The Protozoa of the Haji-bei and Kuyalnik *limans*. No less than 130 species were found in the former, which contains a greater number of marine forms, and 75 in the latter.—Chemical researches in the Marmora Sea, on board the *Selanik*, by A. Lebedintseff. Preliminary report, from which it appears that the existence of bacteria producing sulphuretted hydrogen in the water and the mud of the Marmora Sea cannot be doubted.—On a globular syenite on the Bazavluk, by M. Sidorenko.—On the salinity of the Haji-bei and Kuyalnik *limans*, by Prof. Werigo.—Physical and chemical exploration of the Odessa *limans*, by A.

Lebedintseff and W. Krzyzanowski.—Geological explorations along railway lines in South Russia, by V. Laskareff.—On the sexual reproduction of *Schizoneura lanigera*, by S. Mokrzecki (with a coloured plate).—On the influence of substitution on the rate of certain reactions, by P. Petrenko Krichenko.—*Crangon vulgaris*, var. *Shidlovskii*, from the Sea of Japan, by Dr. A. Ostroumoff.

Vol. xxi. part 1.—Materials for the fauna of Coleoptera of South Russia, by E. Kubkovski. An elaborate work which contains a review of the corresponding literature, a sketch of the distribution of Coleoptera in the Steppes, the sandy regions, the waters, &c., and a detailed enumeration of the species.

Memoirs of the Novorossian (Odessa) Society of Naturalists, Mathematical Section, vol. xvii.—Solar radiation, by M. Pantchenko. The author submits to a careful mathematical investigation the different formulæ proposed by Violle, Langley, Abney, Bartolli, Crova, Angot, and Angström. For purely meteorological purposes he finds Angström's formula sufficient; it gives very good results with the actinometric measurements made in Odessa in 1890, 1891 and 1894.

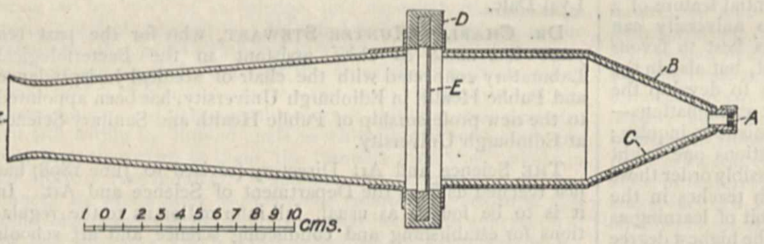
SOCIETIES AND ACADEMIES.

London.

Royal Society, June 16.—"On the Source of the Röntgen Rays in Focus Tubes." By Alan A. Campbell Swinton. Communicated by Lord Kelvin, F.R.S. Received June 7.

The author has already described at the Royal Institution (see Nature for May 26, page 91) how he has found it possible to study by means of pin-hole photography the active area on the anti-kathode of a focus tube from which the Röntgen rays proceed.

By means of a special camera he has now been able to make further investigations. In the illustration A is the pin-hole in a



lead disc secured by a cap to the brass cone B, which is lined with thick lead. D is a framework into which slides either the fluorescent screen E, or a carrier containing a sensitive plate should photographs be required. F is an observation tube for use with the fluorescent screen. It is made of insulating material to avoid danger of shocks.

With this apparatus directed at the anti-kathode of a focus tube, it is easy with the fluorescent screen in place to take accurate note of the image of the active anti-kathode area which appears on the screen, and to observe the variations in form, dimensions, and brilliancy that take place under varying conditions. Similarly by replacing the fluorescent screen by a photographic plate the image can be photographed.

The following are the main effects that the author has observed.

(1) When the anti-kathode intersects the kathode stream at the focus, the dimensions of the active area are independent of the degree of exhaustion. For all other positions beyond the focus it is larger the lower the exhaustion and *vice versa*.

(2) When the anti-kathode intersects the kathode stream beyond the focus, the active area is larger the greater the distance between kathode and anti-kathode.

(3) When the anti-kathode intersects the kathode stream considerably beyond the focus, the active area is found to consist of a well-defined and very intense central nucleus, surrounded by a much fainter but quite appreciable halo. Both of these increase in size as the distance between kathode and anti-kathode is increased. In some cases the halo consists of a well-marked hollow ring with a dark space between it and the central nucleus. In other cases two distinct concentric rings are visible surrounding the nucleus.

(4) With an anti-kathode inclined at an angle of 45° to the axis of the conical kathode stream, it is found that those portions of the stream which impinge most normally upon the anti-kathode surface are considerably the most efficient in producing Röntgen rays.

(5) At the degrees of exhaustion most suitable for producing Röntgen rays, and with concave kathodes of the usual dimensions, the kathode stream proceeds almost entirely from a small central portion of the kathode surface, the remaining portion of the surface being apparently practically inoperative. That this is so was very conclusively established by photographs taken with a tube in which three very minute fragments of glass had attached themselves on to the concave surface of the aluminium kathode. The shadows of two of these fragments appeared in the photographs, and enabled accurate measurements to be made.

(6) The different portions of the kathode stream proceeding from different portions of the kathode cross at the focus and diverge in a cone that retains any special characteristics of the convergent cone. The relative positions of the glass fragments on the kathode, and the positions and enlargement of their shadows on the anti-kathode were found to show this very clearly.

(7) Though by far the greater portion of the Röntgen rays given by a focus tube proceed from the active anti-kathode area, still a very appreciable quantity is also given off by all those portions of the glass of the tube that shows the green fluorescence.

Further, it is noticeable that that portion of the glass that shows the brightest fluorescence, *i.e.* that part which lies in the path in which kathode rays would be reflected from the anti-kathode surface were they reflected according to the law of equal angles of incidence and reflection—gives off the most Röntgen rays, while those portions of the glass that show no fluorescence do not give off any Röntgen rays. The conclusion appears obvious that whatever produces the one also produces the other, but as has been pointed out by Prof. S. P. Thompson the fluorescence is not due to the direct stream of rays from the kathode, but to some description of radiation that proceeds from the surface of the anti-kathode that faces the kathode.

Prof. Thompson calls these radiations "para-kathodic rays," stating that they differ from the Röntgen rays in respect of their power of penetration, and in their capacity of being electrostatically and magnetically deflectable. In these respects the author's experiments confirm those of Prof. Thompson; but when the latter goes on to differentiate these rays from ordinary kathode rays, on account of their not exciting Röntgen rays where they impinge on a solid surface, the author is unable to agree, for, as above stated, these rays do excite Röntgen rays where they impinge upon the glass walls of the tube.

The "para-kathodic" radiations do not, however, appear to be ordinary kathode rays. In the first place they do not proceed directly from the kathode, but only from the surface of the anti-kathode that faces the latter. Secondly, they do not appear to be negatively but positively charged. The author suggests that they may very probably consist of kathode ray particles which, having struck the anti-kathode, and having thus given up their negative charges and acquired positive charges, rebound, both by reason of their elasticity and also by repulsion from the anti-kathode. Perhaps, owing to the comparative roughness of the anti-kathode surface, they fly off to some extent in all available directions, but they do so especially in that direction which the law of equal angles of incidence and reflection requires. It also appears very possible that these rays are identical with the positively electrified streams proceeding from the anode, which the author has investigated by means of radiometer mill wheels, recently described in his paper to the Physical Society (see Nature for March 31 and June 2, pp. 525 and 119.

"Mathematical Contributions to the Theory of Evolution. V. On the Reconstruction of the Stature of Prehistoric Races." By Karl Pearson, F.R.S., University College, London. Received June 6.

The object of this memoir is to illustrate the general theory by which we may reconstruct from the knowledge of one organ in a fossil or prehistoric race, the dimensions of other organs, when the correlation between organs in existing races of the same species has been ascertained. The particular illustration chosen is the reconstruction of probable stature from a measurement of the long bones.

Up till quite recently this subject remained in great obscurity, partly on account of absence of theory, and partly for want of trustworthy data.

The estimated statures as obtained by Orfila, Topinard and Beddoe, or by use of their methods, differ widely, and those methods have no satisfactory theoretical basis. It was usual to suppose that there was some mean or average ratio of stature to long bone, and even when it was recognised that this ratio varied with the length of the long bone, it was thought sufficient to determine it for two or three separate ranges of stature, and determine its mean value for these ranges by a very limited number of cases.

The first stage in advance was taken when Rollet published his measurements, made in the Anatomical Theatre at Lyons, of the stature and long bones of 100 corpses. Rollet's attempt to establish ratios on the basis of his measurements is not very satisfactory, but to him belongs the credit of having first provided a respectable, if not large amount of data. Rollet's work was followed by a very able memoir on the reconstruction of stature by Manouvrier. There are many traces in Manouvrier's paper of the old view of a "coefficient" by which the long bone must be multiplied in order to obtain the stature. Beyond this view, it cannot be said to contain any theory, and it suffers from certain marked defects.

Manouvrier's memoir was rapidly followed by an excellent piece of work from Rahon, who collected measurements of the long bones of a very wide series of local races of man, and reconstructed their stature by aid of Manouvrier's tables.

The present memoir starts with the theory of probability, which the author has already applied to other problems in evolution, and deduces the most probable stature for any combination of the four long bones. It is shown that for a population with normal correlation, the relation between stature and one or more long bones is always linear. A general theorem is proved to show that no linear function of the long bones can give the probable stature with so small a probable error as the regression formula of the theory of probability. From this result the following conclusions are obtained:

(*a*) No constancy of the ratio stature to long bone is theoretically to be expected, but the ratio of deviation from mean stature to deviation from mean long bone, *i.e.* the regression coefficient is the quantity, the constancy of which might be anticipated.

(*b*) No method of predicting individual stature from the individual long bones, whether one or all are used, can give a result wlth a less probable error than 2 cm.

(*c*) For the same length of femur, tibia, and humerus, the stature is shorter the longer the radius. This result has considerable bearing on the relationship of man to the anthropomorphous apes.

Formulæ are then obtained for the reconstruction of probable stature as measured:

(*a*) On the corpse, from the lengths of the long bones containing animal matter, and with the cartilages attached. These will possibly be of service for purposes of criminal investigation.

(*b*) In life, from the lengths of the long bones without cartilages, and free of all animal matter.

Corrections are given for cases in which the femur is measured in the oblique position; the tibia is measured with the spine; and the left-, instead of the right-, hand members are known.

The manner in which natural selection modifies the regression formulæ is indicated. It is pointed out that the divergence between such regression formulæ really enables us to predict to some extent the nature of the differential selection which has taken place between two local races. To test how far we may safely apply our formulæ to other than French measurements, the stature of the Ainos ♂ and ♀ is reconstructed by means of them from Koganei's measurements of the long bones, and the result is found to be very satisfactory. With a view of illustrating the change in the regression formulæ owing to selection, the anthropomorphous apes are considered, and it is shown that the gorilla, in the regression formulæ for femur and tibia stands much closer to man than either the chimpanzee or orang.

The formulæ are applied to reconstruct the stature of prehistoric, mediæval and modern races. The modern populations occupying the same districts of Europe as Palæolithic and Neolithic man appear to be taller, but in the case of both south Germany and France there appears to be a slight, but sensible, decrease of stature since proto-historic times. Modern English do not seem to have decreased in stature since the ancient Anglo-Saxons. In the estimates of stature for the above races, the author differs, in some cases very considerably, from previous writers.

Beyond the range of normal population (say from 157 to 175 cm. for ♂), the line of regression ceases to be linear. An attempt is made, such as existing data will allow of, to express the line of regression by the equation to a curve. The prediction of the stature of dwarfs from the curve obtained from the data for giants shows only 2·25 cm. mean error, and must be considered satisfactory. Application is then made of the results to reconstruct the stature of Bushmen, Andamanese, Akkas, and of European neolithic dwarfs.

PARIS.

Academy of Sciences, July 11.—M. Van Tieghem in the chair.—On the decomposition of nitric acid by heat at moderately high temperatures, by M. Berthelot. Pure nitric acid is not decomposed when kept in the dark at the ordinary temperature, but at 100° measurable amounts of oxygen and nitrogen peroxide are produced. Nitric acid of specific gravity 1·333 is not appreciably decomposed under similar conditions.—On the compressibility of air considered as a gaseous mixture, by M. E. H. Amagat. In air, the oxygen and nitrogen appear to be compressed, as if each were at the pressure of the mixture; the volume of the mixture is sensibly equal to the volume of the constituents. A table is given showing the deviations found experimentally for pressures between 100 and 3000 atmospheres, deviations which are within the known experimental error.—On the systems of differential equations satisfied by quadruply periodic functions of the second species, by M. Martin Krause.—On a mode of supporting the motion of a pendulum, by M. A. Guillet. The impulses are given electrically by induction currents at the same point in its path, one as it ascends, and the other as it descends, the disturbances thus set up being exactly equal and of opposite sense. Comparisons with a free pendulum showed that the time of vibration was unaltered by the use of the mechanism described.—On the passage of electromagnetic waves from a primary wire to a secondary wire parallel to it, by M. C. Gutton.—On the mode of oxidation of cobalt salts in alkaline solutions, by M. André Job. It has been known for some time that cobaltous salts, treated with potassium bicarbonate and hydrogen peroxide, give a higher oxidation product having a green colour, the exact composition of which has not hitherto been proved. By means of the ferrous reducing agent recently described by the author, it is now shown that the oxygen taken up corresponds to Co_2O_3. The estimation of cobalt in presence of nickel and iron is easily carried out by this method.—Action of heat upon the double nitrites of the alkalis and metals of the platinum group.—Compounds of rhodium, by MM. A Jolly and E. Leidié. At 440° the double nitrite $Rh(NO_2)_6.6KNO_2$ is decomposed into nitrogen, nitric oxide, and a salt having approximately the composition $K_2Rh_6O_{13}$ or $K_2O.6RhO_2$. These results are considered as affording evidence in support of the oxide RhO_2.—On the production of tungsten blue, by M. Albert Granger. By the use of a mixed tungstate of barium and sodium a fine indigo-blue glaze is imparted to porcelain, if the temperature is about 1250°, and the heating carried out in a reducing atmosphere.—On the yttrium earths arising from the monazite sands, by M. G. Urbain.—On the brominating action of aluminium bromide in the fatty series, by M. A. Mouneyrat. Ethylene bromide, treated with $AlBr_3$ at 110° C. gave acetylene. With bromide and aluminium bromide, ethyl bromide is readily converted into ethylene dibromide, and the latter again into symmetrical tetra-bromethane. From this hexabromethane can be obtained without difficulty.—On some mixed phenyl-alkyl-carbonic ethers, by MM. P. Cazeneuve and Albert Morel. A description of the mode of preparation and physical properties of the phenylmethyl, phenylethyl, phenylpropyl, phenylisopropyl, phenylisobutyl, phenylisoamyl, and ethylallyl carbonates.—On the saponification velocity of some phosphoric ethers, by M. J. Cavalier.—Action of tetrazodiphenyl, tetrazodiorthotolyl, and tetrazodiorthoanisyl chlorides upon methyl and ethyl cyanacetates, by M. G. Favrel.—On the phosphates in urine, by M. L. Jolly. The facts noticed by MM. Lépine and Aubert, and explained by them by the assumption of incomplete oxidation of phosphorus in the urine, are shown to be susceptible of another explanation. —Presence of chlorophyll in a nostock cultivated entirely in the dark, by MM. A. Étard and Bouilhac. The green colouring matter, previously noticed by M. Bouilhac, is here proved to be ordinary chlorophyll.—On a product of decomposition of albumen, by M. J. M. Albahary. In an attempt to prepare an iodine derivative of albumen, a new acid was obtained, oval-buminic acid, forming a definite, crystallised sodium salt, and also a gold salt. The molecular weight of the acid determined by means of the latter was 1670.—Action of the sorbose bacteria upon xylose, by M. Gabriel Bertrand. The bacterium exerts an oxidising action, an acid, xylonic acid, being formed in small quantity.—New biological absorvations upon the life in colonies of the fixed tunicates, by M. Antoine Pizon.—Alkaline reaction of the chambers and galleries of ants' nests. Duration of life of decapitated ants, by M. Charles Janet.—Improvement of the wild carrot, by grafting it on the cultivated carrot, by M. Lucien Daniel.—Results of the ascents of three experimental balloons at Trappes, on June 8, by M. L. Teisserenc de Bort. The height attained was 13,000 metres, the lowest temperature $-59°$ C.—On a means of avoiding collisions at sea by means of electromagnetic waves, by MM. A. Berget and L. Décombe. —On stereoscopic vision in kinematography, by M. Aug. Rateau.

AMSTERDAM.

Royal Academy of Sciences, May 28.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Schoute, on cyclographic representation in space of Joachimthal's circles.—Prof. Haga, on maxima and minima of apparent brightness, resulting from optical illusion. When in a plane on which the eye is fixed, two zones of mutually different, but each in itself of uniform (or slowly varying) intensity of light are connected by a zone the intensity of light of which gradually decreases from that of the lighter to that of the darker zone, then the transition zone seems to be separated from the brighter one by a still brighter line and from the darker one by a still darker line. This optical illusion, which occurs under very different circumstances, and the peculiarities and possible explanation of which were briefly indicated by the author, is important: (1) because it has already often (*e.g.* in the case of X-shadow figures) made investigators imagine that they observed diffraction or other important lines; (2) because it is not impossible that, for the above reason, the indistinctness of the edge of a dark or a light line may give, or have given rise to the observation of an apparent doubling of such a line; (3) because it may lead to an incorrect estimation as to the place of the maxima and minima in systems of lines, in which the intensity of light is not symmetrically distributed with respect to the middle of those lines.—Prof. Beyerinck, on the relation of obligatous anaerobics to free oxygen. The moving bacteria present in great numbers in preparations for the microscope, which allow the air to enter at the edge of the cover-glass, arrange themselves in special figures according to their greater or smaller predilection for oxygen. The author has called them "figures of respiration." Formerly he thought that three types might be distinguished: the "aerobic type," represented by those bacteria which seek the highest tension of the dissolved oxygen; the "spirillous type," corresponding to a medium; and the "anaerobic type," corresponding to a minimum tension. Further researches have shown that the anaerobic type, characterised by the accumulation of anaerobic bacteria at the place where the oxygen tension is smallest—generally the centre of the drop—does not exist as a special case, and is only observed when the quantity of oxygen that enters, exceeds a certain minimum, and that at this minimum or below it all observed anaerobics arrange themselves into the figure of the "spirillous type," *i.e.* they do not seek the smallest tension, but a medium one, like the spirilli themselves. Consequently not three, but only two types exist, which may be termed *aerophily* and *micro-aerophily*. It can be shown that what has been said about the mobility holds good for the growth of some, possibly of all anaerobics, so that it is not absolute absence of oxygen that is most beneficial for their growth. The experiment is made by sowing a very great number of non-aerated germs of anaerobics together with a very great number of oxygen-absorbing aerobics in a solid culture mass contained in a glass tube, allowing diluted air to enter at only one end. A level of maximum growth of the anaerobics may then be observed, not deep down, where oxygen is quite absent, but at some distance from the surface, where the tension is most favourable for them, which clearly shows that anaerobics are micro-aerobics also in relation to growth. The anaerobic material, used for the experiment, must be taken from cultures, long continued with the exclusion of oxygen, which enables them to grow deep down in the tube. It is probable that the possibility of their aerobiosis depends on this very oxygen charge quite in the same way as is the case with alcohol yeast. In conclusion all living organisms, examined up to the present moment, are aerophilous or micro-aerophilous with respect to mobility as well as to growth.—Mr. Hamburger on the influence of salt solutions on the volume of animal cells, being at the same time a contribution to the knowledge of their structure.—Mr. P. Zeeman presented a paper on an instance of asymmetry in the change of the spectral lines of iron, radiating in a magnetic field.—Prof. Kamerlingh Onnes presented, on behalf of Mr. E. van Everdingen, jun., a communication entitled "Hall's effect in electrolytes." A formula for this effect in the case of a partially dissociated electrolyte is deduced. By means of the simpler formula for the effect in a completely dissociated solution, the numerical value of the rotation of the equipotential lines in a special case is calculated and compared with the result of Bagard's experiments in the same case. The theoretical value proves to be 10^6 times smaller than the observed value. The author concludes that the difference of potential, observed by Bagard, is due to disturbances, already indicated by Chiavassi and others.

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