THURSDAY, DECEMBER 10, 1891.

GERMAN TECHNOLOGY FOR ENGLISH MANUFACTURERS.

A Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali. By George Lunge, Ph.D. Second Edition. Vol. I. Sulphuric Acid. (London: Gurney and Jackson, 1891.)

The Alkali-maker's Hand-book. By George Lunge, Ph.D., and F. Hurter, Ph.D. Second Edition. (London: Whittaker and Co., 1891.)

SULPHURIC acid plays a part, directly or indirectly, in every manufacturing industry of civilized countries. It has been said, indeed, that one could gauge the civilization of a country by the amount of oil of vitriol it consumes. It is satisfactory, therefore, to know that Great Britain produces annually nearly a million tons of this civilizing agent, or an amount but slightly less than that made by all the rest of the world.

It is, however, a remarkable and not very creditable fact that no English or Scotch man has been at any particular pains to give his fellow-men an adequate description of the details of manufacture of this civilizing agent. Of course a certain number of books of a kind have appeared; but it has been left to a German Professor to give us the first complete monograph on the subject. No one is more competent than Prof. Lunge to write authoritatively concerning the manufacture of sulphuric acid. For eleven years previous to his election to the Professorship of Technical Chemistry at the magnificently equipped Polytechnic School which the forethought and patriotism of the Swiss Government have caused to be erected at Zürich, Dr. Lunge was the manager of a large alkali-works in the north of England; and he has added to the experience thus gained by numerous visits to the other alkali manufacturing districts of Great Britain, and to those of Belgium, France, Germany, and Austria. His work, however, is not wholly based on the results of personal observation; it reflects, in fact, the existing state of chemical literature on the subject, for practically every important memoir or communication, wherever published, bearing on the manufacture, properties, or uses of sulphuric acid, is referred to and judiciously criticized. Moreover, the author's position, as director of one of the most modern and in many respects one of the best-appointed laboratories in the world, gives him unique advantages in the compilation of such a work; for, surrounded as he is by a band of earnest and enthusiastic workers, eager to aid him in elucidating the theory of established chemical manufactures or in investigating the validity of new processes, he is able to throw light on many obscure reactions by the systematic researches which he initiates, and of which the results, so far as they relate to sulphuric acid or collateral matters, are set forth in this book. It has been frequently observed that, although iron and oil of vitriol are among the most important of our staple products, we know comparatively little of the many chemical reactions which are concerned in their formation. The remark has, however, lost much of its force within recent years, and more especially in the case of sulphuric acid. During the last few years the various changes occurring within the leaden chamber have been more carefully traced, and much definite information has been gained as to the natur of the interactions which result in the production of oil of vitriol. For not a little of this information we are indebted to Prof. Lunge and his pupils.

The present edition of this work differs in many respects from its predecessor. The ten years which have elapsed since the appearance of the first edition have seen many important changes in the manufacture of acid and alkali; and hence, with a view of bringing his treatise within reasonable compass, Prof. Lunge has been obliged to curtail much of the historical or merely retrospective portion of the work, and to omit matter which deals with views and theories which may now be considered obsolete. In spite of all this, the book has greatly increased in size, and nearly half the illustrations are new. A comparison of the two editions shows that every page has been carefully overhauled, and much fresh information is given, even on points which appeared to be settled and accepted. The present edition is remarkably free from press errors. We have only detected two: on p. 108, calcium "bisulphate," should read "bisulphite"; and on p. 899 we read that SO_3 is formed when *limestone* is burnt in oxygen, especially at increased pressures; of course "limestone" is a *lapsus calami* for "brimstone."

"The Alkali-maker's Hand-book," as it is now called, has an accepted position in the laboratory literature of the chemical works of this country. The book owes its origin to a suggestion, made by Mr. Stroof, manager of the Griesheim Alkali Works, to the German Society of Alkali-makers, that a standard manual should be published, with a view of securing uniformity in analytical methods, tables of specific gravity, &c., to be employed by buyers and sellers for the valuation of chemicals, and by manufacturers for controlling and superintending their various processes, in order to avoid disagreements, and to secure exact comparison of results. A small committee of the Society was appointed, and Prof. Lunge was commissioned to collect and sift the materials for such a manual. The present work is the outcome of this action. The great danger of a book of this kind is that it is apt to get stereotyped, in the extended and figurative sense of that word; and that, owing to the natural conservatism of manufacturers, who are loth to disturb arrangements which are found to satisfy commercial necessities, there is the possibility that it may fail to reflect the state of quantitative analysis of the time. So long, however, as the work remains under the direction of Dr. Lunge and Dr. Hurter, there is very little chance of such a fate overtaking it. The present edition gives abundant evidence that care is being taken to make the book a faithful record of the condition of contemporary quantitative analysis. The work is conveniently arranged and well printed. We would take exception, however, to the character of the illustrations: these compare most unfavourably with those in Dr. Lunge's larger work. Simple outline drawings, like that of the nitrometer on p. 113, would be far preferable to the ill-drawn, ill-cut, and ill-printed designs which disfigure the book. Much of the value of the book depends, of course, on the care and accuracy with which the tables of chemical contents are compiled. We do not regard, however, the value 122 as the atomic weight of antimony, and we strongly protest against the continued use of 197·18 as the atomic weight of platinum. We are aware of the reasons which have led to the adoption of this value, but not even a "Potash Convention" has the right to play fast and loose with a stoichiometric constant to the extent of nearly 3 units from the truth. Similar tricks were played in the old days with the atomic weights of sodium and manganese for commercial purposes. Let the Potash Convention agree among themselves to adopt any correction they please on their analytical results with a view of rendering them more accurate; but they have no right to tamper with an atomic weight in order to compensate for the imperfections of their quantitative methods. For table 22, showing the volumes of water at different temperatures, we should have preferred to use the more accurate table of Rossetti, which gives the mean results of the observations of Kopp, Pierre, Despretz, Hagen, Matthiessen, Weidner, and Kremers, and thereby tends to eliminate errors due to the employment of a special method, such, for example, as the dilatometrical method. We may also point out that the table of solubilities of certain gases in water is not based on the most modern data. Bunsen's values for oxygen have been superseded by the more accurate numbers of Winckler, Dittmar, and Roscoe and Lunt, Sondén and Petterson; and the original statement, based apparently on the work of Carius, that hydrogen is equally soluble in water at all temperatures between 0° and 20°, has been shown to be erroneous by Bohr and Bock and Timofejew.

There is a passage in the preface of Prof. Lunge's larger work which may serve to indicate the difference with which the scientific aspect of his business is regarded by the English and Continental chemical manufacturer. In presenting his book to English manufacturers, Dr. Lunge ventures to express the hope that they will not think it too "scientific." He counsels them not to despise the purely chemical detail which they will find in it. There is, it may be thought, a certain element of humour in these remarks. But Prof. Lunge is very much in earnest. He very well knows that we are still ruled by the rule of thumb in these things; the "practical man" still dominates, and nothing but the inevitable adverse dividend will move him out of the way. To what consequences the neglect of a scientific treatment of a practical subject leads, Prof. Lunge illustrates from his personal experience. He tells us that he left his native country for Great Britain rather more than five-and-twenty years ago, because industrial chemistry was but little developed in Germany:—

"The manufacture of sulphuric acid, soda-ash, and bleaching-powder was at that time quite insignificant in Germany, and not very considerable in France as compared with Great Britain; nor could the technical appliances, the yields, or even the purity of the products in the two former countries vie with those of the latter."

How different matters are now is notorious:—

"The manufacture of chemicals has made enormous strides forward, both in quantity and quality, in France, and even more so in Germany. Many of the chemicals of these countries outstrip those of English works in purity; and their plant and their processes are frequently superior to those used in the majority of English works. Everybody knows how this has come about. The foreign chemists and manufacturers have looked all round, not merely in their own countries, but wherever they could find improved methods and apparatus; and upon the practical knowledge thus gained they have brought to bear the scientific training they had received at their Universities and Polytechnic schools. Thus they have already, in many fields formerly remunerative to British manufacturers, distanced the latter, immensely aided though these be by their long occupation of the ground, and by permanent natural advantages, such as cheapness of coal and freight, and their superior command of capital, &c.; and this is likely to go on to an increasing extent if many British chemical manufacturers decline to profit from a scientific study of their respective branches."

No one who has had the opportunity of comparing German chemical works with those of this country can be blind to the truth of these remarks. In certain branches of manufacture we are now absolutely distanced by the Germans, and in branches, too, which by priority of start and by every natural advantage ought to have been our exclusive possession. In the case of some of these we can hardly hope to recover our lost ground. Attempts have not been wanting, but it has to be admitted that British pluck and British capital have been hopelessly beaten by German energy and German capital *plus* German foresight and enlightenment. In some of these industries we may still hope to have a part, but it can only be a secondary one; and if things go on as hitherto, we must be content to be as the hewers of wood and the drawers of water. As we sow so shall we reap; and as we have sown little, it is but little that we may expect to garner.

The development of industrial chemistry in Germany during the last twenty years, and especially in those branches which depend upon the higher and more recondite branches of the science, has been amazing. In the manufacture of organic products the Germans and Swiss practically command the markets of the world; nor is there the least indication that their monopoly in the case of such products as demand scientific training and skill will be or can be assailed by us at present.

Some months ago the writer was required to inspect and report upon the best examples of modern chemical laboratories to be met with on the Continent, with special reference to the work of instruction in chemical research, and in the higher branches of chemical teaching. The advice he received was most significant, and illustrates very strikingly the attitude of the German chemical manufacturer towards the science of his business "If you want to see how organic chemistry should be worked at," said Prof. Kekulé, "go to some of our manufactories: they show us the way now. The men whom we have trained in our academic laboratories have bettered their instruction and teach their teachers." Precisely the same counsel was given by Prof. Victor Meyer: "Do you wish to see how chemical research can be organized? Then go to Ludwigshafen." And to Ludwigshafen we went. The mental impression of that spectacle of "organized research" on the banks of the Rhine will not soon be effaced. The sight, indeed, would constitute a useful object-lesson to the legislators who have sought to grapple with the subject of secondary education by handing it over to the country gentlemen. The very existence of such gigantic concerns as Meister, Lucius, and Brüning, and the Badische Anilin und Soda Fabrik, with their thousands of workmen, their splendidly equipped laboratories, and their scores of well-trained investigators, the product of the most advanced chemical instruction that the most eminent teachers in the world can impart, is a sufficient indication of what "the scientific treatment of a practical subject" leads to.

Some days after his visit to Ludwigshafen, the writer met Prof. von Baeyer at Munich, and the talk was of Höchst and Ludwigshafen, and the influence which these and many such places must have on the industrial position of Germany. "And do you know to whom we owe all this?" asked Baeyer. There was but one answer: "To Liebig." "You are right. It is to Liebig and the Giessen laboratory." What the Augustinian cell at Wittenberg was to German theology, the little University laboratory was to German chemical science.

"The foundation of this school," says Hofmann, who was himself one of its products, "forms an epoch in the history of chemical science. It was here that experimental instruction, such as now prevails in our laboratories, received its earliest form and fashion; and if at the present moment we are proud of the magnificent temples raised to experimental science in all our [German] schools and Universities, let it never be forgotten that they all owe their origin to the prototype set up by Liebig half a century ago."

Bureaucracies, being human institutions, have occasionally been known to err, but that bureaucrat who—by recalling the two Prussian students who had dared to seek the instruction in Hesse-Darmstadt which they failed to get in their own State—raised the storm of indignation which found eloquent expression in the famous letters that roused Germany and Austria to a sense of what science could do for their material interests, has deserved a better fate than oblivion. T. E. THORPE.

DIPHTHERIA.

Diphtheria: its Natural History and Prevention. By R. Thorne Thorne, M.B., F.R.S., &c. (London: Macmillan and Co., 1891.)

THE volume before us is a republication of the Milroy Lectures, delivered by Dr. Thorne Thorne before the Royal College of Physicians in London, 1891; and all must heartily congratulate the author on the ability with which he discusses a complex and vastly important subject, and at the same time must be grateful to him for having, by republication in a handsome form, made these lectures accessible to a larger public.

Diphtheria is an infectious disease which was known before the Christian era, and was fully recognized and well described by Bretonneau in 1821. In this country it has of late years undergone, both as to its diffusion and mortality, a remarkable increase. While in former years diphtheria was considered a purely "rural" disease, of late years its repeated occurrence in large towns has raised it to an "urban" disease; so much so that, "while the metropolitan (death) rate (from diphtheria) for 1861–70 was lower than that for the country generally, it exceeded it during the two next periods, and the rise which has taken place in the rate for 1881–89 is far in excess of the corresponding one for England and Wales." "There is thus far evidence that diphtheria as a cause of death is increasing in the country as a whole, and that this increase is very conspicuous in our greatest urban community" (p. 5). It is significant that, "concurrently (pp. 80–81) with the diminution of enteric fever, owing to advance of knowledge in the principles of health, and with the resulting intelligent administration of our sanitary laws, we find that the diphtheria death-rate is increasing in our midst." "But it is, above all, in our large towns and cities that this enlightened sanitary policy has been most marked during the past twenty years; . . . and yet, whereas when, in the past, sanitary defects abounded in our large centres of population diphtheria was essentially a disease of rural districts, that disease is now invading our more cleanly towns and cities to an extent unknown in the annals of their more faulty past."

Now, what is this increase of diphtheria in general, and the "formidable" increase in the London mortality from diphtheria in particular, due to? Although Dr. Thorne abstains from supplying a direct answer to this question, an attentive reader, after perusal of the enormous body of facts which Dr. Thorne produces, will be in a position to draw his own conclusions. This increase is certainly not to be explained by the better recognition and more correct classification of the disease (in the earlier returns of the Registrar-General certain forms of scarlatina, true diphtheria, and certain non-diphtheritic forms of croup are not well distinguished, in the later returns the distinction is carefully carried out), nor can this increase, obviously, be due to any new condition as to soil, water, and air. Dr. Thorne passes in review, and illustrates by numerous examples, collected by the most competent sanitary officers and inspectors, and minutely described in the Reports of the Medical Officer of the Local Government Board, the various conditions that have been, or were suggested as having been, connected with the origin and spread of various diphtheria outbreaks in this country; and a careful perusal of the immense body of facts recorded in this volume must impress the reader, not only with the great caution with which Dr. Thorne draws his conclusions, but with the admirably impartial way in which he tells his story, and in which he pays due regard to every detail, be it for or against. The one fact which above all others stands out prominently, and which it behoves everyone connected with our present system of compulsory school attendance carefully to consider, is the unmistakable influence of "school attendance" on diphtheria. Not the fact that diphtheria spreads from a child affected with diphtheria to another child with which it is brought in contact, either at school or at play or otherwise—a fact only too well known and unfortunately often enough actually illustrated; but the fact that "school influence"—that is, an influence affecting children aggregated in a confined space—has an important bearing on the generation of true diphtheria. This "'school influence' tends to foster, diffuse, and enhance the potency of diphtheria; and this, in part at least, by the aggregation of children suffering from that sore throat which commonly is prevalent antecedent to, and concurrently with, definite diphtheria" (p. 219). Dr. Thorne devotes a considerable portion of chapter iii. to the consideration and discussion of this important subject, and brings forward evidence, collected by himself before and after 1878, and by a number of well-known health officers and co-workers (Mr. W. H. Power, Dr. David Page, Dr. Jacob, Dr. Bruce Low, and others), which conclusively proves and confirms Dr. Thorne's proposition, first enunciated by him in 1878. Over and over again has it been shown (chapter iii.) that, in schools frequented by children some of whom were affected with simple sore throat, outbreaks of true diphtheria have occurred, for the explanation of which no antecedent case of diphtheria, nor any of the generally assumed insanitary conditions, could be brought forward. It is on these grounds that Dr. Thorne justly insists on a continued and careful inspection of the throats of the children, and on immediate separation from school of any child affected with sore throat.

The part that milk plays in the dissemination of diphtheria is fully discussed, and illustrated by a number of epidemics that have been recorded in the Reports of the Medical Officer of the Local Government Board; and the important relation of diseases of the lower animals, particularly of cows and cats, is also described and illustrated by epidemics in chapter iv. Last, but not least, Dr. Thorne considers the question of prevention and isolation. By his office as Assistant Medical Officer of the Local Government Board, and from an experience extending over many years, he stands in the unique position of the very best authority, whose conclusions and recommendations deserve carefully to be studied by managers and owners of schools, by hospital authorities, by sanitary officers and Boards of Health, by the owners of dairies, and by all those to whom the health of the community ought to be of paramount importance.

THE NEW YORK MATHEMATICAL SOCIETY.

Bulletin of the New York Mathematical Society, a Historical and Critical Review of Mathematical Science. Vol. I. No. 1, October 1891. (New York: for the Society.)

WE have occasionally wondered that now the study of mathematics is so diligently and successfully prosecuted across the Stream, there was no Society to bring together all such persons as were willing "to encourage and maintain an active interest in mathematical science." The "Organization of the New York Mathematical Society" gives a list of 174 members, mostly Professors of Mathematics or Astronomy. The President is Mr. Emory McClintock, a Vice-President of the Actuarial Society of America, who is also a member of the London Mathematical Society, and a contributor of some excellent memoirs to the *American Journal of Mathematics.* The constitution embraces six articles, and there are ten by-laws. These are apparently founded upon the rules which have been drawn up for other similar Societies. The date of the pamphlet (*i.e.* the "Organization, &c.," cited above) is June 1891. From a circular we gather that the Society has only recently inaugurated the present state of affairs, for this document states:—

"The New York Mathematical Society has consisted in the past of most of the professors and instructors of mathematics at the several Colleges situated in New York and the vicinity, the actuaries of a few of the larger life insurance companies, and a number of other persons interested in higher mathematics. At present an extension of membership is in progress."

Then it goes on to say:—

"The Society is about to undertake the publication of a periodical review of pure and applied mathematics. The idea is not to enter into any competition with the *American Journal of Mathematics*, the *Annals of Mathematics*, or any other similar journal, but it is proposed to publish, primarily, historical and critical articles, accounts of advances in different branches of mathematical science, and reviews of important new publications; also *résumés* of lectures before the Society, short contributions from members and correspondents, and general mathematical news and intelligence. Such a periodical, if circulated extensively, will do much to incite an interest in mathematical studies, and to maintain the interest of those who, having pursued such studies, are now perhaps at a distance from others of like tastes and training. It will appeal to many that our mathematical journals do not reach."

We have allowed the Society to state its aims: these have been sanctioned by Profs. Newcomb, Woolsey Johnson, and Craig (associate editor of the *American Journal of Mathematics*). We wish the Society every success in their endeavour "to promote a long-needed spirit of active co-operation, and to establish a bond of union between American mathematicians."

The *Bulletin* contains an article on "Octonary Numeration," by Prof. Woolsey Johnson. The concluding paragraph is as follows:—

"As there is no doubt that our ancestors originated the decimal system by counting on their fingers, we must, in view of the merits of the octonary system, feel profound regret that they should have perversely counted their thumbs, although Nature had differentiated them from the fingers sufficiently, she might have thought, to save the race from this error."

The rest of the number is taken up with reviews of several books, viz. "The Teaching of Elementary Geometry in German Schools" (review of Schotten's "Inhalt und Methode des planimetrischen Unterrichts," by Prof. Ziwet); Bertrand's "Calcul des Probabilités" (by Prof. Ellery Davis); Fine's "Number-System of Algebra" (by G. Eneström, of Stockholm); and notices of works on West African longitudes and South American longitudes (by the treasurer, H. Jacoby). There are several short notes and a translation of Picard's demonstration of the general theorem upon the existence of integrals of ordinary differential equations (by the secretary, T. S. Fiske).

From this account it will be seen that there are no mathematical memoirs read before the Society in this part, but that such papers have been communicated we learn from the fact that three are printed in the current number of the *American Journal of Mathematics*, viz. one by C. Steinmetz (February 6, 1891), and two by the President (March 6, 1891).

OUR BOOK SHELF.

Delagoa Bay: its Natives and Natural History. By Rosa Monteiro. With Twenty Original Illustrations after the Author's Sketches and from the Natural Objects by A. B. and C. E. Woodward. (London: George Philip and Son, 1891.)

BOTANISTS and zoologists alike will remember the services rendered to science by the late J. J. Monteiro, in conjunction with his wife, both in western and eastern tropical Africa, and his modest volumes on Angola and the River Congo, dedicated to his partner in the pleasures and dangers of life in a tropical climate, and his zealous aid in the collecting of objects of natural history. He was one of the three almost contemporaneous discoverers of that very remarkable plant the *Welwitschia mirabilis*—the others being Welwitsch and Baines; and he sent some of the finest specimens of it in existence to this country.

After the loss of her husband, Mrs. Monteiro returned to Delagoa Bay, and spent five years in solitude, in the cottage built for her under happier circumstances, devoting her time to collecting insects, birds, and other natural objects, and studying the life-history of insects and their relations to plants. The present book is an unpretentious narrative of her life and labours during that period, and a record of her observations and her experiments in breeding insects, illustrated with some of her own discoveries in the animal and vegetable kingdoms.

A Hand-book of Industrial Organic Chemistry. By Samuel P. Sadtler, Ph.D. (Philadelphia: J. B. Lippincott Company, 1891.)

IN this book Prof. Sadtler has attempted to compress into about 500 octavo pages an account of those manufactures which depend upon the applications of organic chemistry. For what particular class of readers such a book is intended is rather difficult to determine. The scientific man is hardly likely to consult it in preference to the numerous special manuals to which he has access; and to the manufacturer the book is practically useless, owing to the comparative absence of all working detail. Considering the volume of literature which is required to give an approximately adequate representation of one industry alone—viz. the tar-colour manufacture—it would seem hopeless to expect anything of value from a chapter on the artificial colouring-matters, which, in well-leaded "roman spaced," attempts to give in 45 pages an account of the production and chemical nature of the numerous artificial and natural organic colouring-matters used in the arts, including their identification, chemical analysis, and detection on dyed fabrics. Certain of the other subjects are, it must be stated in fairness, treated with greater detail; and, as we should expect from Dr. Sadtler's connectionas an expert with the mineral oil industry, his description of the manufacture of petroleum and its associated products is reasonably complete. So also is the account of the cane-sugar industry. But, with the exception of the bibliographical and statistical information which occupies a relatively large share of the space devoted to each article, we see little else to commend. The book, however, is well got up; the paper and printing are all that can be desired, and the illustrations are, as a rule, much better executed than is usual in works of this class.

Progressive Mathematical Exercises. First Series. By A. T. Richardson. (London: Macmillan and Co., 1891.)

THE examples contained in this book are of the most elementary nature, and are intended for the use of those who have got no further than quadratic equations. In this series the exercises only deal with arithmetic and algebra, and are arranged in sets of papers which gradually become more difficult. The examples in arithmetic commence by dealing with the first four rules, simple and compound, and fractions; while those in algebra consist mostly of numerical values, addition and subtraction. Cube root and compound interest in arithmetic, and quadratic equations in algebra, form the highest limit to which these subjects are carried in this series. Throughout the work the author seems to have paid great care to insure accuracy in the answers; and though we have worked out many problems, picked out at random, we failed to find any errors.

We may mention that, in working through the papers, the beginner will occasionally come across examples which appear to be far above the average standard; but these, on trial, will always be found very simple, and are placed there with the intention of encouraging boys to look up methods they have not reached, and so to find that "a little research enables them to do a new sort of question."

Teachers and taught alike should find this book a useful adjunct to the text-book they have in use. W.

LETTERS TO THE EDITOR.

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

The Implications of Science.

IT would be a great misfortune if such views as were expressed by Dr. St. George Mivart in a lecture delivered under the ægis of the Royal Institution, and reported at length in your columns (pp. 60 and 82), were allowed to pass unchallenged. In case no abler challenger appears, will you allow me to say a few words about "the implications of science"?

The great objection I take to Dr. Mivart's view is, that he does not appear to recognize any distinction between a real and a verbal truth. He apparently puts our knowledge of "the law of contradiction" into precisely the same category as our knowledge of "our own continuous existence," and draws but a slight distinction between these items of knowledge and such an item as the law of gravitation. Whereas, in fact, the so-called "law of contradiction" is not a *necessary* truth at all, it only expresses a verbal convention. It is not a law, but is of the nature of a definition. On the other hand, our knowledge of our own existence, *in the present*, comes to us by direct apprehension, and really is a "necessary truth" to each of us individually; though, since our knowledge of our existence in the past depends on the accuracy of our memories, this latter may easily be erroneous. That the memory exists is of course indisputable, but it may well be that the fact it professes to recall either took place differently, or even did not take place at all. Our confidence in our memories depends upon induction—ultimately on *inductio per enumerationem simplicem*—in just the same way as our belief in the law of gravitation does, and neither of these items of knowledge can therefore be necessary truths, though we may well hold them with so strong a conviction that the distinction may for practical purposes be ignored.

The "implications of science" which Dr. Mivart insists on are nearly all truisms (that is, purely verbal assertions)—all those to which he ascribes universal validity in any regions of time or space are such. I may repeat here what I have said elsewhere: "*The supposed peculiar certainty of mathematical conclusions is solely due to the fact that they are truisms.*"

For example, the assertion "Two straight lines cannot inclose a space" is certainly not a "necessary truth." Either its terms are defined by connotation, so that its truth depends solely on those definitions, or else its terms are defined by denotation, as representing real things in space, and the truth of the assertion can only be proved by induction from actual experience with those things. In the first case the truth is arbitrary, not neces sary; and in the second case it might conceivably be false, as was shown by Helmholtz. It is of course true that the imaginary dwellers on a sphere might still *conceive* what we call "straight lines," but if they chose to reserve that term for geodesics of their space they would be within their rights in doing so. This is practically what Euclid does, and this is why he requires "axioms" which are *not* necessary truths; even though, in fact, they are true as far as we can test them.

So also there is no useful sense in saying that twice two must be equal to four under any conditions of time or space. Doubtless, *if* the inhabitants of the Dog Star defined "twice," "two," and "four" as we do, then "twice two" would to them be "four"; but to say that it was so could only give verbal information. And if the people in the Dog Star chose to define four as 1 + 1 + 1, the so-called "necessary truth" would not even be true! Again, we do not "recognize that what we know 'is' cannot at the same time 'not be,'" we *define* it to be so. To know that anything "is," is indeed to possess real knowledge; but in order to conclude that therefore it cannot "not be," we require no further knowledge, except as to the meanings of the words employed in the argument. The "law of contradiction" never tells us whether anything "is" or "is not." It only tells us that the terms "is" and "is not" are not applicable to the same thing. This is part of the definition of the terms. If anyone chooses to say a thing both "is" and "is not," there is no law against his doing so, only if he does so he is not talking the Queen's English. Dr. Mivart is wrong in speaking of the "objective absolute validity of the law of contradiction." Its validity is not only not objective at all, but even subjectively it is not absolute, but depends on the arbitrary meanings assigned to its terms. It is exactly on a par with the assertion that at chess one king cannot give check to another.

EDWARD T. DIXON.

Trinity College, Cambridge, November 29.

The Koh-i-Nur.

ABSENCE from home and pressing business since my return have delayed my sending a reply to Prof. Maskelyne's second article upon the above subject (NATURE, November 5, p. 5). So far as I can discern Prof. Maskelyne's primary object in writing these articles, it is to endeavour to maintain the hypothesis put forward by him many years ago; and with this object in view he has made a number of statements, from which I have culled not a few that may be ranged under either of two heads—firstly, those which I believe can be shown to be distinctly contrary to the evidence; and secondly, those which, if not directly contradicted by the evidence, are quite unsupported by it. In my first reply I gave samples of these statements which afforded perfectly clear issues, and as these have been unanswered, it is useless to refer to others in detail at present.

Some readers of what has already been written have expressed to me their regret that finality has not been attained by this discussion. For my own part I have a feeling of sincere regret at any additional confusion being introduced into the subject. Some of the statements referred to may, unless a warning be given, be quoted in the future, as others have been in the past, by writers who may not have the means or may not be willing to take the trouble to refer to the original authors.

There are several references in Prof. Maskelyne's last article to authors with whose writings I have considered it to be my business and duty to make myself familiar. I possess their works, and of one of them I have recently published a detailed commentary, while of another I have a commentary in course of preparation. Among these authors are Garcia de Orta and Chappuzeau, and Prof. Maskelyne's remarks lead me to conclude that he has not a very intimate acquaintance with their writings and with those of some of their contemporaries. From internal evidence it is practically certain that at the time Garcia wrote his book he had not visited the Mogul's Court, and could not, therefore, have seen his jewels, though, for the sake of argument, Prof. Maskelyne suggests he had. As for the discredited Chappuzeau, whose malicious statements are quoted without their refutation, I need only say that Prof. Joret's investigations have cleared Tavernier of the charges of plagiarism, &c., which were made against him, and they have further disclosed the fact that his own original manuscript documents, from which the "Travels" were prepared, are still extant (see preface to the second volume of my edition of the "Travels").

Now, as to the De Boot mistake, to which Prof. Maskelyne again refers as though it had an important bearing on the subject, it is the case that Mr. King, in a footnote, pointed out the error in De Boot's quoting as from Monardes. The footnote does not occur in Mr. King's account of the diamonds, but elsewhere. When I wrote, I had Prof. Maskelyne's quotation (*Edinburgh Review*), as from Mr. King, before me, and thus I was for the moment misled as to the extent of Mr. King's knowledge. Seeing, then, that it was Prof. Maskelyne's misquotation which misled me, his not having accepted my invitation to explain, coupled with his crowing over me for having been misled (by his own words), is one of the most extraordinary features in this controversy. Two years ago I annotated my original paper with the remark that Mr. King *had* noticed the mistake of De Boot about Monardes, but it was then too late to correct the press.

The confusion which has most unfortunately been introduced into this subject by authors has now, it is to be fervently hoped, culminated in the publication by Prof. Maskelyne of a figure of a huge mounted jewel, which, going much further than his previous reference to it might have led one to expect, he labels "The Mogul." What the authority may be for this sketch, we are not clearly informed; all, apparently, that can be said for it is that "it speaks for itself." I cannot understand how Sir John Malcolm can be responsible for it, at least as it is labelled, because I know what he has published about the Shah's jewels, especially the Darya-i-Nur and its companion the Taj-e-mah. Kerr-Porter, Eastwick, and others who have described the Shah's jewels, make no mention of the existence of any such stone as this figure represents.

"It speaks for itself"; and I must venture by two alternatives to hazard an interpretation of what it says. Firstly, the amorphous-looking mass may be intended to represent some uncut stone, possibly a ruby; but why should it be the Mogul's diamond, which is known to have been cut? Secondly, it seems to be more probable that the figure may have been taken from a native sketch which originally professed to represent, but greatly exaggerated the size, and omitted the facets, of the Koh-i-Nur. Prof. Maskelyne says it was accompanied by two other stones in the same mount: so was the Koh-i-nur (see the copies of the original model in the Tower and in several public museums). The character of the mount is somewhat similar to that in the Hon. Miss Eden's sketch of the Koh-i-Nur. This is all that, as it appears to me, can be legitimately deduced from this figure which has been left "to speak for itself."

As to Prof. Maskelyne's own sketch of the Koh-i-Nur, I thank him for it, because I think it may perhaps serve to aid readers who have not seen the original in accepting the hypothesis put forward by me, that it had been mutilated after cutting.

Through the kindness of Mr. L. Fletcher, F.R.S., Keeper of the Minerals in the British Museum, I have recently had an opportunity afforded me of seeing the original plaster model of the Koh-i-Nur, and of comparing it with a glass model similar to the one upon which my remarks as to the mutilation were based, and I find them to be identical in form and all essential details.

V. BALL.

Dublin, November 13.

Pfaff's "Allgemeine Geologie als Exacte Wissenschaft."

IN this work (Leipzig, 1873) there is a speculation (on p. 162) that in early geological times the carbonic anhydride, while yet free on the surface of the earth, was sufficient in quantity to exert a pressure of 356 atmospheres. If this had been the condition of things at any time when the surface temperature was below the critical temperature (30°·9 C.), it follows that abundant liquid carbonic anhydride flowed over the surface of the earth, or floated upon the seas; unless it be supposed, which is not probable, that this quantity could be held in solution in the water. Other very important and interesting effects are also involved. The statement of the 356 atmospheres has been quoted without question by so high an authority as Dr. Irving in his "Metamorphism of Rocks."

Pfaff's result, however, is based on a statement of Bischof's (as quoted by Pfaff), that the calcium carbonate of all formations would suffice to cover the surface of the earth to a depth of 1000 *füsse*. Pfaff takes 44 per cent. of this to be CO_2, and assumes the specific gravity of the rock to be 2·6.

On these data, and taking the *fuss* as = 0·3 metre (as stated elsewhere by Pfaff), the CO_2 would exert a pressure, not of 356 atmospheres, but of 33·2, approximately. It appears, in fact, as if Pfaff's result was, through some oversight, calculated as just ten times too great.

Perhaps there is some other explanation of the discrepancy. But, lest it prove an error, I have thought well that attention should be drawn to it, the statement being made on such high authority.

J. JOLY.

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SEISMOMETRY AND ENGINEERING IN RELATION TO THE RECENT EARTHQUAKE IN JAPAN.

AT 6.38 a.m. on October 28, I was awakened at my house in Tokio by the long swinging motion of an earthquake. There was no noise of creaking timbers, and there were no shocks such as usually accompany earthquakes. It was an easy swing, which produced dizziness and nausea. As recorded by bracket seismographs this continued for ten or twelve minutes. During the interval there was ample time to study the movements of these instruments, and the conclusion that could not be avoided was that rather than acting as steady points these heavy masses were simply being swung from side to side—horizontal displacement was not being measured, but angles of tip were being recorded. That many of our seismographs are useless as recorders of horizontal motion whenever a vertical component of motion is recorded, is a view that I have held for many years, and therefore when these two have been recorded in conjunction I have been inclined to receive the records with caution.

Further, the measurement of vertical motion as recorded by a horizontal lever arrangement can only be trusted if we can assure ourselves that the advance of the waves has been at right angles to the direction of the lever. If this condition is not fulfilled, then the seismograph for vertical motion may also become a tip-recording instrument. As another indication that during this particular earthquake earth tips occurred, I may mention that the water in a tank with perpendicular sides which is about 25 feet deep, 60 feet long, and 30 feet broad, rose quickly, first on one side and then on the other, to a height of 3 or 4 feet—much in the same way that water would rise and fall in a basin that was being tipped from side to side.

Assuming what is said to be correct, it must not be concluded that modern seismographs are useless. For earthquakes where the motion is horizontal, they give records which practically are absolutely correct. When vertical motion occurs, in many cases if not in all, the records must be interpreted in a new light. The so-called horizontal displacements may be employed in determining the maximum slope of a wave, and if from an instrument recording vertical motion we are assured that we have measured the vertical height of a wave, we can at least approximate to the length of the same. The period of the waves being recorded, it follows that the velocity of propagation may be calculated.

Although it seems possible to use our present bracket seismographs as angle measurers, it is evident that there are other types of instruments, where swing due to inertia is minimized, which will act more satisfactorily. To obtain a true measure of vertical displacement, the most evident solution would be to use a number of lever arrangements in different azimuths. Other methods may, however, suggest themselves.

For the present our time is too much occupied with outside observations to attend to instruments or to reduce their records. Up to date it is known that nearly 8000 people have been killed, many having been consumed in the burning ruins where they were entombed. At least 41,000 houses are level with the plain, and engineering structures which have stood both typhoon and flood have been reduced to ruin. In the middle of the stricken district, which is near Gifu and Ōzaki, it is doubtful whether any ordinary building could have resisted the violence of the movement; but outside this, much destruction might have been obviated had attention been given to the ordinary rules of construction, and to the special rules formulated by those who have considered the question of building in earthquake countries. In many places so-called "foreign" buildings of brick and stone—undoubtedly put up in the flimsiest manner—lie as heaps of ruin between Japanese buildings yet standing. Cotton mills have fallen in, whilst their tall brick chimneys have been whipped off at about half their height. Huge cast-iron columns, which, unlike chimneys, are uniform in section, acting as piers for railway bridges, have been cut in two near their base. In some instances these have been snapped into pieces much as we might snap a carrot, and the fragments thrown down upon the shingle beaches of the rivers. The greatest efforts appear to have been exerted where masonry piers carrying 200-feet girders over lengths of 1800 feet have been cut in two, and then danced and twisted over their solid foundations considerable distances from their true positions. These piers have a sectional area of 26 × 10 feet, and are from 30 to 50 feet in height. Embankments have been spread outwards or shot away, brick arches have fallen between their abutments, whilst the railway line itself has been bent into a series of snake-like folds and hummocked into waves. The greatest destruction has taken place on the Ōkazaki-Gifu plain, where we have all the phenomena—like the opening of crevasses, the spurting up of mud and water, the destruction of river banks, &c.—which usually accompany large earthquakes. At Ōkazaki and Nagoya the castles have survived. The reason for this may be partly attributable to the better class of timber employed in their construction, but principally to their pyramidal form and to the fact that they are surrounded by moats. Here and there a temple has escaped destruction, partly, perhaps, on account of the quality of materials employed in its construction, but also in consequence of the multiplicity of joints which come between the roof and the supporting columns. At these joints there has been a basket-like yielding, and the interstice of the roof has not, therefore, acted with its whole force in tending to rupture its supports. On the hills which surround the plain, although the motion has been severe, the destruction is not so great. These hills are granites, palæozoic schists, and other rocks. There is nothing volcanic. In the small cuttings where the railroad passes from the hills out into the plain, no effects of disturbance are observable, the surface motion probably having been discharged at the faces of the inclosing embankments. The general appearance outside the cuttings, however, is as if some giant hand had taken rails and sleepers and rubbed them back and forth until the ballast lying between them was formed into huge bolster-like ridges. Crossing the hills and proceeding to other plains, it is noticeable that there has been more movement on the alluvium than on the rocks.

Earthquakes yet continue, and in the Gifu plain each one is preceded by a boom as if a heavy gun had been fired in some subterranean chamber. Although the survivors, who may number, perhaps, two millions, are, for the most part, destitute, have witnessed the most terrible scenes, and are yet surrounded by the dead and the dying, yet there is no panic. They hear a "boomb," and run laughing to the middle of the street to escape the shock which the unaccountable noises herald. The Japanese have their feelings, but on occasions of this sort there is no helplessness in consequence of hysteria or mental prostration. As to what happens with Europeans under like circumstances, I must leave readers to consult history.

JOHN MILNE.

Tokio, November 7.

FURTHER RESEARCHES UPON AZOIMIDE, N_3H.

THE discovery of this remarkable compound of hydrogen and nitrogen by Prof. Curtius, in the chemical laboratory of the University of Kiel, formed one of the most interesting chemical events of last year. The extraordinary nature of the compound—manifested by its fearfully explosive properties, together with its acid character, by virtue of which it forms salts with metals containing only metal and nitrogen—mark out for it a place among the most attractive of hitherto discovered substances. It was first obtained by Prof. Curtius in the form of a gas, by treating with soda a compound containing the organic radicle benzoyl in the place of the hydrogen atom, and subsequently warming the sodium salt thus produced with dilute sulphuric acid. The gas was described as possessing a frightfully penetrating odour, and as being absorbed by water with extreme avidity, forming a solution of strongly acid properties, which liberates hydrogen in contact with metals. So great, indeed, is the affinity of azoimide for water, that in these earlier experiments it was not found possible to collect the gas in the anhydrous state. Shortly after the publication of his first communication (see NATURE, vol. xlii. p. 615), an improved method of preparing the solution in water was devised by Prof. Curtius. It consisted in distilling a soda solution of a derivative containing the radicle of hippuric acid with dilute sulphuric acid. He was thus enabled to obtain a tolerably large quantity of the aqueous acid. By successive fractionation of this solution in water, and finally distilling the last product of the fractionation over fused calcium chloride, pure azoimide itself was eventually isolated, and found to be a volatile liquid, boiling at 37°.

Owing to the terribly explosive nature of both the free acid and its salts, the work has been attended with considerable danger, and has, unfortunately, been delayed by a lamentable accident which befell Prof. Curtius's assistant, Dr. Radenhausen, who was seriously injured by the explosion of a quantity of the anhydrous acid. At length, however, Prof. Curtius is able to publish some further particulars concerning the acid and its salts, and an important communication from him will be found in the current number of the *Berichte* of the German Chemical Society. The following is a brief account of these further researches, together with a *résumé* of the present state of our knowledge of this interesting compound and its derivatives.

Sources of Azoimide and its Derivatives.

Azoimide and its salts have been obtained from two distinct sources, both organic. One source, the first employed by Prof. Curtius, is benzoyl-glycollic acid, $C_6H_5CO{-}O{-}CH_2COOH$; the second is hippuric acid, $C_6H_5CO{-}NH{-}CH_2COOH$. During the investigation of the reactions of his previously discovered compound of hydrogen and nitrogen, hydrazine, N_2H_4, Prof. Curtius found that both benzoyl-glycollic and hippuric acids reacted with hydrazine hydrate, forming hydrazine derivatives.

Benzoyl-glycollic acid reacts with two molecules of hydrazine hydrate, forming benzoyl hydrazine, $C_6H_5CO{-}NH{-}NH_2$, and the hydrazine derivative of acetic acid, $NH_2{-}NH{-}CH_2COOH$, with elimination of water. When benzoyl hydrazine is treated with nitrous acid, it is converted into a nitroso derivative, $C_6H_5CO{-}N\langle{}^{NO}_{NH_2}$. This nitroso compound is a very unstable substance; it spontaneously parts with water, and becomes converted into the benzoyl derivative of azoimide, benzoyl-azo-imide, $C_6H_5CO{-}N\langle{}^{N}_{N}\|$. This latter compound forms a direct starting-point for the preparation of azoimide. Upon boiling with alkalies an alkaline salt of azoimide is formed, together with benzoate of the alkali. Thus with soda

$$C_6H_5CO{-}N\langle{}^{N}_{N}\| + 2NaOH = C_6H_5COONa + NaN\langle{}^{N}_{N}\| + H_2O.$$

When the sodium salt of azoimide is distilled with dilute sulphuric acid, azoimide escapes as a gas, which condenses along with water in the form of an aqueous solution.

Hippuric acid reacts with one molecule of hydrazine with formation of hippuryl hydrazine, $C_6H_5CO{-}NH{-}CH_2CONH{-}NH_2$. When this substance is treated with nitrous acid, a compound is obtained which was at first considered to be a nitroso compound, but is now discovered to be in reality a diazo compound possessing the constitution $C_6H_5CO{-}NH{-}CH_2CONH{-}N{=}N{-}OH$. This substance may be isolated in quantity, and yields salts of azoimide directly upon treatment with alkalies. If soda is employed the sodium salt of azoimide is obtained, from which azoimide itself may, as before, be liberated by distilling with dilute sulphuric acid. It is more convenient, however, as will be described later, to employ it directly for the preparation of the ammonium salt of azoimide by saturating its alcoholic solution with ammonia gas; from the ammonia salt, if desired, azoimide itself may be obtained by converting it into the insoluble silver salt, and distilling the latter with sulphuric acid.

Preparation and Properties of the Sodium Salt of Azoimide, $Na{-}N\langle{}^{N}_{N}\|$.

The method of preparing the sodium salt of azoimide, now adopted as most convenient by Prof. Curtius, is somewhat different from the earlier one just described, although based upon the same lines. Instead of benzoyl-glycollic acid, ethyl benzoate, $C_6H_5COOC_2H_5$, is employed. This substance is converted readily into benzoyl hydrazine by treatment with hydrazine hydrate:

$$C_6H_5COOC_2H_5 + N_2H_4 \,.\, H_2O = C_6H_5CONH{-}NH_2 + C_2H_5OH + H_2O.$$

The benzoyl hydrazine is next treated with sodium nitrite and glacial acetic acid, whereby it is quantitatively transformed into benzoyl azoimide, the benzoyl derivative of the new acid:

$$C_6H_5 \,.\, CONH{-}NH_2 + HNO_2 = C_6H_5CO{-}N_3 + 2H_2O.$$

The benzoyl azoimide thus obtained is finally dissolved in an equal weight of absolute alcohol, and the equivalent of an atom of sodium is also dissolved in a little absolute alcohol, and the two solutions mixed; the mixture is then digested for several hours upon a water-bath, when the sodium replaces the benzoyl radicle, and ethyl benzoate is regenerated:

$$C_6H_5CO{-}N_3 + C_2H_5ONa = C_6H_5COOC_2H_5 + Na{-}N_3.$$

Upon cooling, the solution deposits crystals of the sodium salt, and the remainder may be precipitated from the mother-liquor by means of ether. The ethyl benzoate is recovered by distillation with very little loss, and may be employed again for the preparation of a further quantity of the sodium salt of azoimide.

The sodium salt, NaN_3, obtained by this method is substantially pure. It is very soluble in water, but is, strangely enough, not hygroscopic. It is almost insoluble in ether and alcohol. It gives a feebly alkaline reaction, and possesses a briny taste. The crystals do not explode by percussion, but do explode when heated to a temperature which is higher than in the case of most other salts of azoimide. The explosion is accompanied by the production of a brilliant yellow flame and a detonation which is less loud than in the case of other salts. The salt is not volatile, and is not changed by evaporation of its aqueous solution.

Preparation and Properties of the Ammonium Salt, $NH_4-N\langle{}^{N}_{N}\| .$

The ammonium salt, which is by far the most convenient salt to start with for the preparation of the free acid and its metallic salts, is best prepared from the curious diazo compound of the amide of hippuric acid, $C_6H_5CO-NHCH_2CO-NH-N=N-OH$, before mentioned. This substance is readily obtained in calculated quantity by first acting with hydrazine hydrate upon the ethyl ether of hippuric acid, and subsequently treating the hippuryl hydrazine thus produced with sodium nitrite and glacial acetic acid. Diazo-hippuramide appears to be most prolific in its reactions. Prof. Curtius states that it reacts with almost every class of organic and inorganic bodies with which he has brought it in contact, and generally without the application of external heat. Thus, when treated with water, alcohol, haloid ethers (alkyls), aldehydes, free halogens, or hydrazine derivatives of organic acids, it evolves free nitrogen gas, and forms compounds which are derived from hippuramide by replacement of a hydrogen atom in the NH_2 group by the radicle of the reacting substance. On the other hand, when acted upon by alkalies, ammonia or substituted ammonias (amines), or by diamide (hydrazine) and its derivatives, salts of azoimide are formed. Thus last reaction, when ammonia is employed, forms the most convenient mode of obtaining the ammonium salt of azoimide.

About a pound of diazo-hippuramide is placed in a flask of 2 litres capacity, and covered with 600 grams of 85 per cent. alcohol. The flask is then placed in a freezing mixture, and ammonia gas is led in until the liquid is saturated with it. The flask and contents are then allowed to stand twenty-four hours in order to complete the reaction, when the diazo compound is quantitatively converted into hippuramide and the ammonium salt of azoimide:

$$C_6H_5CO-NHCH_2CO-NH-N=N-OH + 2NH_3 = C_6H_5CO-NHCH_2CONH_2 + NH_4-N_3 + H_2O.$$

The liquid is then boiled, the flask being fitted with an upright condenser, until no more ammonia escapes, when the heat is removed, and the solution allowed to cool. After standing another twelve hours, the clear alcoholic solution is decanted from the mass of hippuramide crystals, and treated with four times its volume of ether, when 70 per cent. of the total yield of the ammonium salt is precipitated in the form of a white powder. The remaining 30 per cent. of the azoimide may be recovered by recrystallizing the hippuramide from water, adding the mother-liquor to the ethereal-alcoholic solution after removal of the precipitated ammonium salt, and treating the whole of the liquid with solutions of lead, silver, or mercurous salts, when the azoimide is precipitated in the form of the difficultly soluble lead, silver, or mercurous salts. The hippuramide is readily converted, by boiling with hydrazine hydrate, into hippuryl hydrazine, which may thus be used again for the preparation of more of the diazo compound.

The precipitated ammonium salt is washed with ether and dried in the air. The snow-white crystalline powder thus obtained, consisting of fine anisotropic needles, may be recrystallized from boiling alcohol. It is only sparingly soluble in absolute alcohol, but on boiling for some time in a flask fitted with inverted condenser, the whole passes into solution. Upon cooling, the salt separates out in large colourless crystals, tabular in form, and frequently aggregated in step or fan-shaped forms. These aggregates often resemble those of ammonium chloride very closely, but the crystals do not belong to the cubic system. The crystals are readily soluble in water, and, upon allowing the aqueous solution to evaporate *in vacuo*, large transparent prisms are obtained, which, however, soon become turbid in air.

The ammonium salt of azoimide reacts in a feebly alkaline manner. It is not hygroscopic, although so readily soluble in water. It dissolves easily in 80 per cent. alcohol, but, as above described, with difficulty in absolute alcohol. It is insoluble in ether and benzene. It is distinguished by its great volatility. When the crystals are allowed to lie exposed to air, they gradually disappear, eventually passing away entirely in the form of vapour. Upon gently warming a small quantity of the salt in a test-tube to a temperature very slightly superior to 100°, it sublimes like ammonium chloride, condensing again, however, in brilliant little prisms. This operation requires great care, for if the heating proceeds too rapidly the substance explodes with great violence.

As may be expected, great difficulties were met with in obtaining an analysis of a substance so explosive. Upon attempting to determine its composition by combustion with copper oxide in a stream of dry air, the apparatus was destroyed upon each occasion with a fearful detonation. Only one-tenth of a gram of the salt was employed, placed in a small platinum boat. At first the compound sublimed out of the boat into the cooler portion of the combustion tube; the little sublimed crystals then commenced to fuse into yellow drops, and immediately this occurred, in each experiment, the tube was shattered to fragments with a frightful report. The platinum boat was in each case torn to fine splinters. Eventually, however, Prof. Curtius succeeded in obtaining a satisfactory analysis by performing the combustion with copper oxide in a stream of carbon dioxide.

The ammonium salt may be readily converted into the sodium salt by evaporation with caustic soda upon a water-bath.

Preparation and Properties of Free Azoimide, $H-N\langle{}^{N}_{N}\| .$

An aqueous solution of azoimide may be prepared by distilling any of its salts, preferably the sodium or silver salts, with dilute sulphuric acid. It is more conveniently obtained, however, by dissolving the crystals of diazo-hippuramide in dilute caustic soda, warming the solution for a short time upon a water-bath, so as to insure the formation of the sodium salt, and subsequently distilling the liquid with dilute sulphuric acid. The latter is allowed to drop slowly from a dropping funnel upon the soda solution contained in a flask and maintained at the temperature of ebullition. The flask is connected with a condenser, and the azoimide, as it escapes, is carried along with the steam, and condenses in the receiver in the form of an aqueous solution. This solution may be concentrated by precipitating it with silver nitrate, collecting the insoluble silver salt, and distilling it with sulphuric acid diluted with eight times its volume of water.

The aqueous solution of azoimide possesses a most intolerable odour.

Free azoimide itself may be obtained by the fractional distillation of the concentrated aqueous solution thus prepared. The first fraction is collected separately and refractioned. Upon repeating this process with four successive first fractions, an acid containing over 90 per cent. of azoimide is obtained, which distils at about 45°. The last 10 per cent. of water may be completely removed by means of fused calcium chloride, after treatment with which pure anhydrous azoimide distils over.

Azoimide is a clear, colourless, mobile liquid, which boils without decomposition at 37°. It is endowed with the same intolerable odour as the solution. Its most characteristic property, however, is its frightful explosiveness. It explodes in a most erratic manner—sometimes, without the least apparent provocation, at the ordinary temperature. Its distillation is an operation attended with great danger; Prof. Curtius and his assistant *have* succeeded, as above described, in isolating it and determining its boiling-point several times; but upon other occasions, under apparently the same conditions, the experiment has ended with a disastrous explosion. When suddenly heated, or touched with a hot body, it always explodes. The explosion is accompanied by an intensely vivid blue flame. The damage wrought by the explosion of very minute quantites is most surprising. The thousandth part of a gram, placed upon an iron plate and touched by a hot glass rod, is sufficient to produce a loud detonation, and considerably distort the iron plate. The twentieth part of a gram was found sufficient to completely pulverize a Hofmann "density" apparatus, when an attempt was made to determine its vapour-density in the Torricellian vacuum at the ordinary temperature. Upon another occasion, seven-tenths of a gram, contained in a closed glass tube, upon removal from the freezing mixture in which it had been immersed exploded with such immense force as to shatter every piece of glass apparatus in the laboratory. It was upon this occasion that Prof. Curtius's assistant was so seriously injured as to cause the temporary abandonment of the work The aqueous solution is almost as explosive as the anhydrous liquid, the explosion of two cubic centimetres of a 27 per cent. solution upon one occasion shattering the glass tube into dust so fine that Prof. Curtius, who was attempting to seal it, escaped uninjured.

The anhydrous liquid readily dissolves in water and alcohol. The aqueous solution is strongly acid to litmus. Magnesium, aluminium, zinc, iron, and even copper are rapidly attacked by it, hydrogen being evolved. Gold and silver are likewise attacked, although not so rapidly. In the case of gold a red solution of the gold salt is formed; the silver salt being insoluble soon prevents further action in the case of silver.

The anhydrous compound appears to be decomposed by *concentrated* sulphuric acid.

Other Metallic Salts of Azoimide.

The silver salt, $Ag{-}N\langle{}^{N}_{N}\|$, is obtained in the form of a white precipitate whenever a soluble silver salt is added to azoimide, its aqueous solution, or solutions of its salts. It resembles silver chloride very closely in appearance, but is not darkened by the action of light. There is very little difficulty in distinguishing between the two salts, however, inasmuch as the silver salt of azoimide partakes of the frightfully explosive properties of the free acid. It is the most dangerous of all the salts to handle. In spite, however, of this explosiveness, Prof. Curtius has *once*, and only once, succeeded in obtaining a determination of its nitrogen content, by combustion in a long layer of copper oxide. The number obtained was 27·65. The value calculated from the formula AgN_3 is 28·00. In every other experiment the tube was shattered into fragments, notwithstanding the finest subdivision and distribution among the copper oxide.

The precipitated silver salt is soluble, like silver chloride, in ammonia. Upon evaporation of the solution, however, instead of obtaining an ammoniacal double compound, the silver salt itself crystallizes out in almost colourless crystals half an inch long. These crystals, as may be imagined, are most delicate objects to handle; they explode even upon breaking the prisms across. They are almost perfectly insoluble in water.

The mercurous salt, HgN_3, is likewise insoluble in water, and may be readily obtained by precipitation of the free acid or its soluble salts with mercurous nitrate. It has the advantage of being more safely handled than the silver salt, and is less sensitive to percussion. It also requires a higher temperature to bring about explosion by heating. It is usually obtained by precipitation in the form of microcrystalline anisotropic needles. It becomes coloured yellow when exposed to light. Like mercurous chloride, it forms a black compound with ammonia.

The lead salt, PbN_6, resembles lead chloride very closely. It is insoluble in cold water, but dissolves somewhat in boiling water, though not to such an extent as lead chloride, about half a gram dissolving in a litre of boiling water. Upon cooling, brilliant colourless needles, attaining sometimes the length of half an inch, separate out. It may be best obtained by precipitating the solution of the sodium or ammonium salt with lead acetate. The precipitate is soluble in excess of lead acetate. The crystals of the lead salt explode with fearful force when slightly warmed. By long boiling with water this lead salt appears to be decomposed, a non-explosive lead compound separating, and free azoimide escaping. Warm acetic acid also dissolves it, with gradual decomposition and liberation of azoimide.

The barium salt, BaN_6, is readily obtained by neutralizing the acid with baryta, and crystallizes from solution in large lustrous crystals. It is likewise a highly explosive salt, and the explosion is accompanied by the production of a brilliant green flame.

Ethereal Salts of Azoimide.

The metallic salts of azoimide may be readily converted into ethereal salts by reacting upon them with haloid ethers. The phenyl ester has been prepared by Prof. Curtius, and is found to be identical in every respect with the long known diazobenzene imide, $C_6H_5N\langle{}^{N}_{N}\|$. The aromatic esters are generally remarkably stable substances, and it was consequently found impossible to obtain azoimide by the direct saponification of diazobenzene imide with soda. Within the last few months, however, Drs. Noelting and Grandmougin, of Mülhausen, have succeeded in preparing azoimide indirectly from diazobenzene imide, by first diminishing somewhat the stability of the compound by introducing two nitro groups into it. Upon treating dinitro-diazobenzene imide with alcoholic potash, the potassium salt of azoimide was at once formed. Upon distilling this with dilute sulphuric acid, an aqueous solution of azoimide was obtained, and eventually anhydrous azoimide itself, identical in all respects with that obtained by Prof. Curtius.

Hydrazine Salt of Azoimide, $N_3H \cdot N_2H_4$.

This interesting substance, formed by the union of equal molecules of the two remarkable compounds, hydrazine and azoimide, whose isolation we owe to Prof. Curtius, is a solid substance forming large well-defined crystals. It is obtained when one molecular equivalent of hydrazine hydrate (the preparation and properties of which were described in NATURE, vol. xliii. p. 205) is added to the ammonium salt of azoimide, and the mixture, placed in a shallow dish, is allowed to evaporate in a desiccator. It is curious, also, that by adding a very concentrated aqueous solution of azoimide, obtained by distilling 60 grams of the lead salt with dilute sulphuric acid, to hydrazine hydrate, until litmus is turned strongly blue by the mixture, one does not obtain, as might be expected, the salt $2N_3H . N_2H_4$; on the contrary, the mono-salt, $N_3H . N_2H_4$, is again formed; and if the mixture is placed in a desiccator containing solid caustic potash and oil of vitriol, crystals of the mono-salt are deposited, and the excess of azoimide escapes and is absorbed by the potash.

The mono-hydrazine salt crystallizes in lustrous, anisotropic prisms an inch long, which melt at 50°. They rapidly deliquesce in air. They are soluble with difficulty in boiling alcohol, and crystallize from the solution, on cooling, in brilliant leafy crystals. The crystals burn quietly with a smoky flame when brought in contact with a flame, leaving no trace of residue. Owing to the strong reducing power of the liberated glowing hydrogen, metallic surfaces upon which the crystals may be ignited become brightly cleaned, as if polished, being freed from the least trace of oxide. When the crystals, however, are rapidly heated, or touched with a white-hot wire, they explode with fearful violence. The explosion may also be brought about by detonating in the neighbourhood a little of one of the metallic salts of azoimide. Even in the deliquesced state the substance retains its fearfully explosive properties.

In conclusion, it may be remarked that Prof. Curtius has further succeeded in preparing a number of derivatives of the as yet unisolated compound of hydrogen and nitrogen, triamide, $NH_2—NH—NH_2$, by the action of the hydrazine compounds of several organic acids upon diazo-hippuramide. The organic radicles are so rigidly attached in these derivatives that he has not yet been fortunate in displacing them. It appears very probable, however, that before long some means of effecting this object will be discovered, and that Prof. Curtius will further add to his achievements by making us as familiar with triamide as we now are with hydrazine and azoimide.

A. E. TUTTON.

BEAST AND MAN IN INDIA.[1]

THE natives of India have been described from many different points of view, but Mr. Kipling is the only writer to whom it has occurred to give a full account of their relations to animals. The task is one for which he is admirably fitted, and he has fulfilled it in a way that cannot fail to secure for the book an enduring place in the literature relating to Indian subjects. The work has considerable scientific value, not only because the author presents the people of India in a new light, but because he has much that is fresh to say about the animals to which he refers. Animals have a great attraction for him, and his notes on their habits have the brightness and charm that belong only to records of direct personal observation. The volume is enriched with many clever illustrations, the majority of which are from drawings by Mr. Kipling himself. Most of the others are from drawings by native artists. Several of these illustrations we are enabled to reproduce.[2]

There is a general impression in Europe that animals are treated kindly in India. This impression is only in part confirmed by Mr. Kipling. It is true that the Hindus, believing in the transmigration of souls, are reluctant to take animal life; but that, says Mr. Kipling, "does not preserve the ox, the horse, and the ass from being unmercifully beaten, over-driven, over-laden, underfed, and worked with sores under their harness; nor does it save them from abandonment to starvation when unfit for work, and to a lingering death which is made a long torture by birds of prey, whose beaks, powerless to kill outright, inflict undeserved torment." Even the sacred cow is not so well treated as the milch cows of Europe. Mr. Kipling's statements on this subject are extremely unpleasant reading, but it is to be feared that they are only too well founded. With regard to free creatures, however, he is able to give a better report. The village school-boy does not stone frogs, or set dogs at cats, or tie kettles to dogs' tails, or go bird-nesting, or annoy squirrels; and "the sparrow, the crow, the maina, and the hoopoe move from his path without a flutter of fear." The farmer, too, endures with extraordinary patience depredations on his crops by wild animals. The monkey, the nilghai, the black buck, the wild pig, and the parrakeet fatten at his expense, and do not even reward him by killing a caterpillar or a weevil. There are bird-catchers in India, but the popular feeling about them is shown in a scornful proverb on their ragged and disreputable condition.

One of the brightest chapters in the book is on monkeys, which the author has had good opportunities of observing. The monkey most commonly seen both in the hills and plains is the Macaque (*Macacus rhesus*), which is not to be confounded with the tall, long-tailed, white-whiskered Langūr (*Presbytes illiger*). The latter is clad in an overcoat of silver-grey. He is, in his way, a king of the jungle, and is not so often met with in confinement as his brown brother. The Hooluck, or Black Gibbon (*Hylobates hooluck*), is most often found in Bengal and Assam, and, if a pair can be secured, easily reconciles itself to captivity; but it is "a depressing companion." An Assam monkey, known as "the shame-faced one," is "a gentle, bashful, large-eyed creature, with a quaint trick of hiding its face in its hands and hanging its head like a timid child."

The monkey is held in great respect in India, and Hanumān, the monkey-god, is one of the most widely-worshipped of Hindu deities. Sacred as the animal is, the people are thoroughly alive to the faults of its character, and in ordinary talk the monkey is used, as in Europe, "to point morals against wanton mischief, helplessness, and evil behaviour generally." For some months a number of wild monkeys were daily fed by Mr. Kipling and his family; and they soon learned to distinguish by smell between fresh and stale biscuits. Yet—as the natives have noted in proverbs—monkeys are not sharp enough to provide themselves with shelter against the heavy rains of the country. In the Simla region they may be seen in troops sitting shivering for hours within a few yards of covered spaces. The scheme of their life, according to Mr. Kipling, seems to be patriarchial, with a touch of military organization, the patriarch being "at once commander-in-chief and effective fighting force." The natives call him "Maharajah," and the name is well chosen, as he is "the very type and incarnation of savage and sensual despotism." Monkey mothers treat their little ones with a tenderness "that endears them to the child-loving Oriental"; and the young, when the sun shines, often contrive to have a good time. Says Mr. Kipling:—

"They have a game like the English boys' cock of the dung-hill or king of the castle, but instead of pushing each other from the top of a knoll or dust-heap, the castle is a pendent branch of a tree. The game is to keep a place on the bough, which swings with their weight as with a cluster of fruit, while the players struggle to dislodge one another, each, as he drops, running round and climbing up again to begin anew. This sport is kept up for an hour at a time with keen enjoyment, and when one is nimble as a monkey it must be splendid fun."

Mr. Kipling finds in cows and oxen the subject of another capital chapter. They seem to him to be the foremost figures in both the rustic and the urban scenery of the country. The cow is now "firmly enthroned in the Hindu pantheon," and the peculiar sanctity in which

[1] "Beast and Man in India." By John Lockwood Kipling, C.I.E. With Illustrations. (London: Macmillan and Co., 1891.)

[2] Figs. 1, 2, and 4, are by Mr. Kipling. Fig. 3 is by Mūnshi Sher Muhammad.

she is held may, he thinks, be partly due to the fact that in early Aryan mythology she was used as a symbol of the clouds attendant on the Sun-god. Mr. Kipling expresses much admiration for Indian oxen, of which he says that it is with them as with the people of India—

FIG. 1.—Young monkeys at play.

"the more you learn about them the more you find to interest you." Fig. 2 represents roughly the range of their size. Even larger beasts than the largest shown sometimes occur. The smallest belongs to a miniature

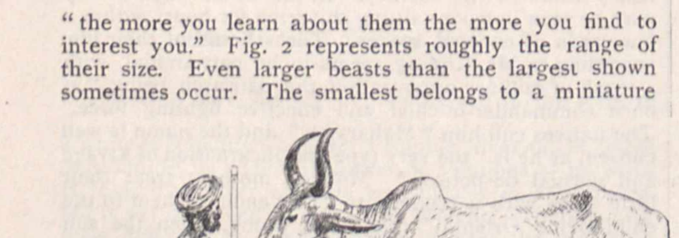

FIG. 2.—Comparative sizes of the largest and smallest breeds of Indian oxen.

race which is not much bigger than a Newfoundland dog. This little creature is exquisitely finished in every detail of ox form; it is full of life and spirit, and, when harnessed to vehicles of a suitable size, it trots at a great pace.

Mr. Kipling notes the peculiar impression produced on Europeans by the silence of Indian cattle. Students, reading in Gray's Ode of the lowing herd, will say to the Professor, "Sir, what is lowing?" Even the grunting note of the ox and cow is seldom heard, and does not carry. The herdsman is a vocalist, but his song "is always in a minor key, and has falsetto subtleties in it that baffle our methods of notation." He talks a good deal in a loud heavy voice; and "when his women folk walk with him they follow respectfully an ordained number of paces behind, and he flings his conversation over his shoulder."

It would be impossible, of course, to write a book about "Beast and Man in India" without treating of

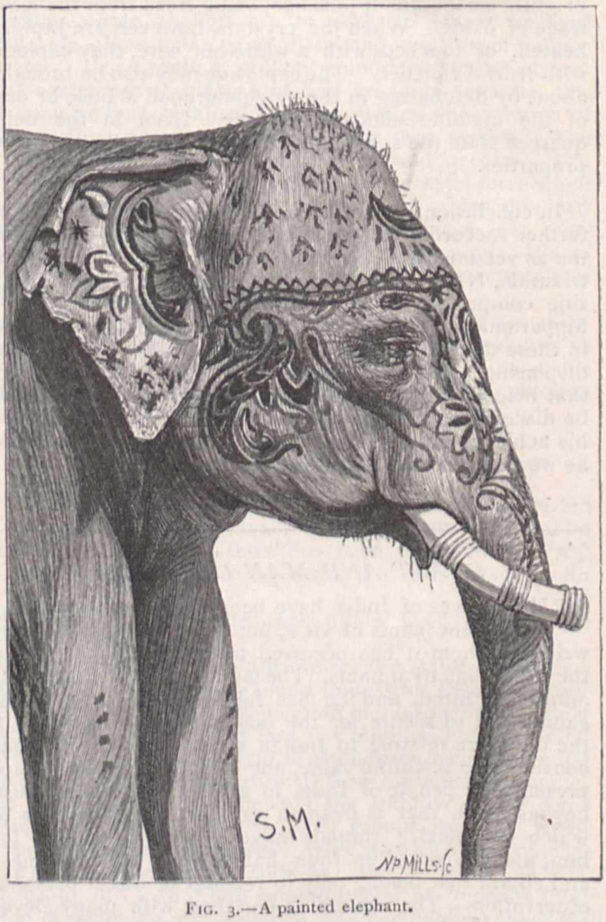

FIG. 3.—A painted elephant.

elephants; and Mr. Kipling discourses on them most pleasantly. The elephant seems to be second only to the cow in Hindu estimation. In Hindu art other animals are treated only in a decorative and conventional style; but in artistic representations of the elephant, whether in sculpture or in painting, there is invariably "a strong feeling for nature." This contrast is seen in most old temples, but especially in the sculptured gates of the Sanchi tope in Central India, "where all kinds of animals are shown, but the elephant alone is carved with complete knowledge and unvarying truth of action."

Mr. Kipling is at great pains to convey a true idea of the character of the elephant, the essential quality of which he takes to be gentleness. He also tells many curious legends about the animal, and about Ganésha, the elephant-headed god, who is not less popular than the monkey-god. The dressing of the elephant for parade is also described. This, although an elaborate process, is not really much more difficult than the dressing of a child for church. The most remarkable part of the process is the painting of the forehead, trunk, and ears, which follows a thorough washing. "The designs are often good, and the whole serai, excepting always the elephant himself, is deeply interested. His mind and trunk wander; he trifles with the colour-pots; so with each stroke comes an order to stand still. Some mahouts are quite skilful in this pattern work."

In an interesting chapter on the training of animals, Mr. Kipling shows that the skill of the natives of India in this difficult art has often been greatly overrated. The Oriental brings "boundless patience" to the task, but "he has no steadfastness of aim, nor has he sufficient firmness of hand and will to secure confidence and obedience." The cheetah or hunting leopard (*Felis jubata*), when caught and tamed, undergoes so little training in the field that it loses its natural dash, and is often left behind by the antelope. It becomes so mild

FIG. 4.—A restless bedfellow.

that it is frequently allowed to curl itself under the same blanket with its keeper. The keeper, when his bedfellow is restless, "lazily stretches out an arm from his end of the cot, and dangles a tassel over the animal's head, which seems to soothe him." In the early morning Mr. Kipling has seen a cheetah "sitting up on his couch, a red blanket half covering him, his tasselled red hood pushed awry, looking exactly like an elderly gentleman in a nightcap, as he yawned with the irresolute air of one who is in doubt whether he will rise or turn in for yet another nap." This is mentioned as an instance of the curious intimacy that exists in India between animals and those who have charge of them.

Of the remaining chapters we can only say that all of them embody the results of a close study of the animal world and of the Hindu character. We may note as of especial interest the three concluding chapters, on animals in Indian art, on beast fights, and on animals and the supernatural.

ON AN OPTICAL PROOF OF THE EXISTENCE OF SUSPENDED MATTER IN FLAMES.[1]

DEAR PROFESSOR TAIT,—I write to put on paper an account of the observation I mentioned to you to-night, in case you should think it worth communicating to the Royal Society of Edinburgh.

In the course of last summer I was led, in connection with some questions about lighthouses, to pass a beam of sunlight, condensed by a lens, through the flame of a candle. I noticed that where the cone of rays cut the luminous envelope there were two patches of light brighter than the general flame, which were evidently due to sunlight scattered by matter in the envelope which was in a state of suspension. The patches corresponded in area to the intersection of the double cone by the envelope, and their thickness was, I may say, insensibly small. Within the envelope, as well as outside, there was none of this scattering. The patches were made more conspicuous by viewing the whole through a cell with an ammoniacal solution of a salt of copper, or through a blue glass coloured by cobalt. In the former case the light from the flame was more weakened than the scattered light, which was richer in rays of high refrangibility; in the latter case the patches were distinguished by a difference of colour, the patches being blue, while the flame (with a suitable thickness of blue glass) was purplish. The light of the patches exhibited the polarization of light scattered by fine particles—that is to say, when viewed in a direction perpendicular to the incident light it was polarized in a plane passing through the beam and the line of sight.

When the beam was passed through the blue base of the flame there was no scattered light. A luminous gas flame showed the patches indicating scattered light like the flame of a candle, but less copiously. They were not seen in a Bunsen flame or in the flame of alcohol, but were well seen in the luminous flame of ether. When a glass jar was inverted over burning ether, the blue part, which does not show scattered light, extended higher, till, just before the flame went out, the luminous part disappeared altogether. A Bunsen flame, fed with chloride of sodium, did not show the phenomenon, though the flame was fairly luminous.

The phenomenon shows very prettily the separation of carbon (associated, it may be, with some hydrogen) in the flame, and at the same time the extreme thinness of the layer which this forms. It shows, too, the mode of separation of the carbon—namely, that it is due to the action of heat on the volatile hydrocarbon or vapour of ether, as the case may be. At the base, where there is a plentiful supply of oxygen, the molecules are burned at once. Higher up the heated products of combustion have time to decompose the combustible vapour before it gets oxygen enough to burn it. In the ether just going out, for want of fresh air, the previous decomposition does not take place, probably because the heat arising from the combustion is divided between a large quantity of inert gas (nitrogen and products of combustion) and the combustible vapour, so that the portion which goes to the latter is not sufficient to decompose it prior to combustion.

In the Bunsen flame fed with chloride of sodium, the absence of scattered light tallies with the testimony of the prism, that the sodium is in the state of vapour, though I would not insist on this proof, as it is possible that the test of scattering sunlight is not sufficiently delicate to show the presence of so small a quantity of matter in a solid or liquid state.—Yours sincerely,

G. G. STOKES.

P.S.—I fancy the thinness of the stratum of glowing carbon is due to its being attacked on both sides—on the outside by oxygen, on the inside by carbonic acid, which with the glowing carbon would form carbonic oxide.

[When the above was written, I was not acquainted with the previous paper by Mr. Burch, published in vol. xxxi. of NATURE (p. 272), nor did any of the scientific friends to whom I had mentioned the observation seem to be aware

[1] Read before the Royal Society of Edinburgh on June 15, 1891. Reprinted from the Proceedings of the Society.

of it. Had I known of it, I should not have thought my paper worthy of being presented to the Royal Society of Edinburgh, as Mr. Burch has anticipated me in the fundamental method of observation.

The reaction mentioned in the postscript is to be taken merely as a specimen of the reactions, on the inside of the carbon stratum, by which the carbon may be re-engaged in a gaseous combination. Carbonic oxide is only one of the combustible gases, not originally present, which are formed during the process of combustion, and are found inside the envelope in which the combustion is going on.—G. G. S., *November* 20, 1891.]

NOTES.

THE annual general meeting of the Institution of Electrical Engineers will be held at the Institution of Civil Engineers, 25 Great George Street, Westminster, this evening (Thursday), at 8 o'clock, for the reception of the annual report of the Council, and for the election of Council and officers for the year 1892. The following paper will be read :—"On the Specification of Insulated Conductors for Electric Lighting and other purposes," by W. H. Preece, F.R.S., Past-President.

THE Royal Danish Academy of Sciences at Copenhagen offers two prizes of 400 and 600 kronen respectively, for investigations on the exact nature and proportions of the more important carbo-hydrates present, at different stages of maturity, in the cereals in most general use; and for investigations on the *Phytoptus* galls found in Denmark, with a monograph on the insects producing them. The prizes are to be awarded in October 1893.

AN improved armillary sphere has been patented by Prof. J. S. Slater, of Calcutta University, which differs from other spheres of the same kind in having a latitude circle to which the celestial sphere is hinged, and in being provided with a movable horizon which adjusts itself to the selected latitude. It can be obtained from Messrs. Walsh, Lovett, and Co., Philpot Lane, E.C.

THE next one-man photographic exhibition organized by the Camera Club will consist of pictures by Mr. J. Pattison Gibson, of Hexham. It will be opened in connection with a concert to be held on the first Monday in January, 1892.

WITH the consent of the Sultan of Muscat, the Survey of India is about to establish a tidal observatory at Muscat. This will probably be followed by the establishment of another observatory of the same kind at Bushire in the Persian Gulf.

WE have had some correspondence with Prof. Arnold about our notice of his speech at the recent meeting of the Institution of Mechanical Engineers. Referring to his remarks on Prof. Roberts-Austen's "Report to the Alloys Research Committee," we expressed the opinion that it was rather straining the prerogative of rhetoric to speak of the work done by Prof. Roberts-Austen as "not worth a rush." We did not intend to imply that Prof. Arnold applied the expression "not worth a rush" to the whole of the work on which Prof. Roberts-Austen reported. He wishes us to state that what he said was, that he thought "any analogue obtained from a comparison of simple bodies like gold and lead with a complex body like steel would not be worth a rush."

THE reports of the examiners on the results of the science examinations held in April and May 1891 have been issued. The examinations related to building construction, naval architecture, mathematics, theoretical mechanics, applied mechanics, magnetism and electricity and alternative elementary physics, chemistry, geology, mineralogy, animal physiology, botany, the principles of mining, navigation and nautical astronomy, steam, the principles of agriculture, and hygiene.

MRS. R. M. CRAWSHAY, writing to us from Mentone, on December 2, about the recent eclipse of the moon, refers to the fact that "the Rev. A. Freeman and Mr. R. T. Leslie are not agreed as to the shadow on the moon's disk having colours or not." For some time there were illuminations and fireworks at Monte Carlo on account of the birthday of the Prince of Monaco, and, when these were over, clouds suddenly came up. "It was only," Mrs. Crawshay says, "when the moon was very nearly half obscured that I caught a glimpse of her without any colouring whatever, orange or otherwise. One could only liken it to a painting in Indian ink."

MR. GEORGE T. BETTANY, who was well-known as a popular writer on scientific subjects, died on December 2 in his forty-second year. For some years he lectured on botany at Guy's Hospital. Conjointly with Prof. Parker, he wrote a work on "The Morphology of the Skull." He was also the author of "The World's Inhabitants," and other books. For Messrs. Ward, Lock, and Co., he edited "Science Primers for the People" and "The Minerva Library."

AN interesting paper on aluminium and its application to photography, by Mr. G. L. Addenbrooke, is printed in the December number of the Journal of the Camera Club. Mr. Addenbrooke thinks aluminium ought now to supersede brass for photographic lenses and the metal parts of cameras. By its use the weight of lenses, flanges, and adapture is reduced nearly to one-third. He is also in favour of aluminium being used for the revolving tripod heads fixed in the bare boards of cameras, as these are rather too heavy in brass. "In hand-cameras," he says, "I think the metal should be useful in most places where there are metal parts. I am also not without hopes that dark slides may be made in it altogether, which will be lighter and more compact than the wooden ones. For developing-dishes, also, it is very suitable, as the action of most of the chemicals used in photography is very slight on it, and when there is any, the compounds formed would not be harmful."

IN his latest communication to the *American Journal of Science* (for November), Prof. Goodale describes his visit to the Queensland Museum at Brisbane, under the charge of Mr. De Vis, rich in specimens illustrating the natural history and ethnology of the colony. An account is also given of the well-known Botanic Garden and Laboratories at Buitenzorg in Java, under the directorship of Dr. Treub, and of the annex on a contiguous mountain; of the Botanic Garden and Experimental Garden at Singapore, under the control of Mr. Ridley; and of the new and at present but poorly developed Botanic Garden at Saigon in French China.

POISONING by mussels is a well-known fact. Such poisoning appears in chronic form in Tierra del Fuego, mussels being abundant on the shores, and other kinds of food rare, so that the natives eat large quantities of the former daily, both of bad and of good quality. According to a doctor of the Argentine fleet, M. Segers, the mussels are rarely injurious at their maximum time of growth, which corresponds with full moon, but when the moon wanes, they become poor and often poisonous. The poisonous quality apparently results from the death of a large number at this time, and the putrefaction of their bodies yielding ptomaïnes which are absorbed by the surviving mollusks. In any case, the Fuegians are often attacked by a liver complaint, consisting in atrophy of the organ, with jaundiced colour of the skin and tendency to hæmorrhage; and M. Segers believes this is due to mussel poisoning. He finds sulphate of atropine an efficacious antidote.

PRINCIPAL J. L. THOMPSON, of the Hawkesbury Agricultural College, New South Wales, has no doubt that the climate and much of the soil of Australia are well suited for the culture of the olive. All that is needed, he thinks, is an adequate supply of labour. He himself has been very successful in preserving green olives; and in a paper on the subject in the August number of the *Agricultural Gazette* of New South Wales he gives the following account of the system adopted. The olives are very carefully picked from the trees when about full grown, but perfectly green. They should be handled like eggs. If they are bruised in any way, they will become black and decompose. In the green state, olives contain gallic acid, which gives them an acrid taste. To remove this they are first of all steeped in alkaline water, made either of wood ashes, lime water, or washing soda; of the latter, about three or four ounces to the gallon of water. As soon as the lye has penetrated through the pulp, which is usually in from eight to ten hours, they are put into clean water and steeped until all acrid and alkaline taste has been removed. During that time the water is changed every day. They are then put into brine, composed of one pound of salt to each gallon of water, and kept carefully covered with a thick linen cloth, for if exposed to the air they will turn black. They are finally put up in air-tight jars.

THE Meteorological Department of the Government of India has published Part IV. of "Cyclone Memoirs," being an inquiry into the nature and course of storms in the Arabian Sea, and a catalogue and brief history of all recorded cyclones in that sea from 1648 to 1889. The work, which has been prepared by Mr. W. L. Dallas, chiefly for the use of mariners navigating those parts, will no doubt be of considerable use to them, as hitherto there were no track charts of the storms in the Arabian Sea for the different months. For the majority of the storms quoted the available materials are admittedly very scanty; nevertheless, the author has been able to draw some useful conclusions from them, with reference to the general behaviour of the storms. The paper is divided into two parts—the first gives the details of each of fifty-four storms in chronological order, the second treats of their geographical distribution and movements according to months and seasons, and the discussion is followed by charts showing the tracks of the storms in the different months. The cyclones are formed on the northern limits of the south-west monsoon; when the northern limits of the monsoon reach the land, and also when the north-east monsoon extends from Asia to the equator, which is the case from December to March, no cyclones are formed over the Arabian Sea. The barometric fall is gradual and equal on all sides, except near the centre, and a depression of 0·25 inch below the average is indicative of the existence of a cyclone in the neighbourhood. When the storms are in confined waters they may burst with great suddenness, but in other cases strong winds are felt for several hundred miles around the centre. The northern parts of the Arabian Sea are liable, during the prevalence of the north-east monsoon, to be disturbed by small cyclonic storms descending from the highlands of Persia and Beluchistan, but the whole of the south-west of the Arabian Sea, though liable to south-west gales during the summer monsoon, and to strong north-east winds during the winter monsoon, is free from cyclones.

DR. STIRLING'S *Notoryctes typhlops*, the lately discovered Australian animal, to which we have repeatedly called attention, forms the subject of an interesting note in the "Hand-List of Australian Mammals," by J. Douglas Ogilby, an advance copy of a portion of which has been forwarded to us. The conclusion at which Mr. Ogilby has arrived, after an exhaustive study of Dr. Stirling's pamphlet, is that in this animal we have at last obtained a definite connecting link between the Monotremes and the Marsupials. At the present stage of our knowledge it would, he thinks, be presumptuous to class *Notoryctes* among the Monotremes proper, although several leading naturalists incline to the opinion that its affinities are closer to these mammals than to the Marsupials. He prefers for the present to look upon it as an aberrant Polyprotodont.

THE Institute of Jamaica has isued the first number of a Journal which is to contain, among other things, contributions regarding newly discovered flora and fauna of the island, and articles dealing with botany and kindred sciences. Four parts will be published in the year. In this first number there are excellent notes, by Mr. T. D. A. Cockerell, on the transformation of some Jamaica Lepidoptera. He points out that, although many species of butterflies and moths have been described from Jamaica, the transformations of very few are known.

DR. A. H. POST, the well-known anthropologist, describing in this week's *Globus* various marriage customs, refers to a strange sort of symbolical marriage which is supposed to have originated in India. It is a marriage with trees, plants animals, or inanimate objects. If anyone proposes to enter upon a union which is not in accordance with traditional ideas, it is believed that the ill-luck which is sure to follow may be averted by a marriage of this kind, the evil consequences being borne by the object chosen. In various regions a girl must not marry before her elder sisters, but in some parts of Southern India the difficulty is overcome by the eldest daughter marrying the branch of a tree. Then the wedding of the second daughter may safely be celebrated. Dr. Post gives several other instances, which are likely to be new to many students of anthropology.

ACCORDING to an official French Report, the copper mines of French Congo are likely to prove of considerable importance. They lie in the district around the sources of the Ludima-Niadi, about two days' journey south of Stéphanieville. The ore is malachite, which is brought to the surface by about 350 negroes. Their methods of work are extremely simple. They reach the malachite by digging out, with implements of hard wood, holes or shafts three feet wide and twice as deep. The malachite is broken on the ground, and afterwards, when pulverized, put into a furnace on a tray with charcoal, on which bellows are made to play. In due time the tray is removed by means of pieces of bamboo, and the metal is poured into sand moulds. The entire district is said to be rich in copper, and masses of malachite are frequently found in the Ludima.

MR. ERNEST E. THOMPSON, of Toronto, contributes to the new volume of the Proceedings of the U.S. National Museum (vol. xiii.) a valuable study of the birds of Manitoba. He gives an enthusiastic description of the music of prairie larks, large numbers of which, at dawn, may be heard in the spring to "burst all together into a splendid explosion of song, pouring out their rich, strong voices from every little height and perch, singing with all their might." They sing all day, and at night joyously hail the moon. As their notes become more complicated, the most casual observer cannot fail to perceive "that the love-fires are kindling, and that each musician is striving to the utmost of his powers to surpass all rivals and win the lady lark of his choice." "On one occasion," says Mr. Thompson, "as I lay in hiding near a fence, three larks came skimming over the plain. They alighted within a few yards of me, and two of them burst into song, sometimes singing together and sometimes alternately, but the third was silent. When at last they flew up, I noticed that the silent one and one of the singers kept together. I had been witness to a musical tournament, and the victor had won his bride."

ANOTHER of the many birds of Manitoba about which Mr. Thompson has something interesting to say is the crane. The first intimation of its advent in the spring is usually a loud trumpeting or croaking that seems to shake the air for miles. But the cranes themselves, generally in pairs, soon begin to be seen. Their food at that season is chiefly rose-pips, in gathering which they stalk over the bare plains. At first little can be noted but their excessive wariness, but as the warmer weather quickens their feeling, they often "so far forget their dignity as to wheel about and dance, flapping their wings and shouting as they 'honour their partners,' and in various ways contrive to exhibit an extraordinary combination of awkwardness and agility." This dance Mr. Thompson has seen only during the pairing season.

REFERRING to the question "whether squirrels are torpid in winter," Mr. C. Fitzgerald writes in the December number of the *Zoologist* that, during many winters passed in the backwoods of North America, he has seen squirrels frisking among the trees in the coldest weather. On bright sunny days especially they delight in chasing each other from tree to tree among the evergreens, and cover the snow with their tracks. The young of the ordinary red squirrel are born early in the spring. The "Chipmunks," or little striped ground squirrels, lay up in the autumn a store of provisions of grains, nuts, &c., for winter, and on fine days may be seen sunning themselves. Mr. Fitzgerald has on several occasions come across their hoards, and once saw two large bucketsful of shelled buckwheat taken from the hollow of an old birch-tree that the woodmen had chopped down on the edge of a clearing which had been cropped the previous summer with that grain.

AT the meeting of the Linnean Society of New South Wales on October 28, the fifth part of Mr. E. Meyrick's "Revision of Australian Lepidoptera" was read. This paper practically concludes the Australian *Geometrina*, except in so far as future discoveries may produce fresh material. One hundred and twelve species are included, of which forty-seven are described as new.

MR. CARL LUMHOLTZ contributes to the current Bulletin of the American Geographical Society a very interesting report on his explorations in Northern Mexico. The most remarkable caves he met with were at the head of the Piedras Verdes River, 6850 feet above sea-level. These caves contain groups of deserted houses or small villages, and the houses are splendidly made of porphyry pulp, and show that the inhabitants had attained a comparatively high culture. The dwellings were sometimes three stories in height, with small windows, and doors made in the form of a cross; and occasionally there were stone staircases. The caves, which number about fifty in a stretch of twenty miles, are from 100 to 200 feet above the bottom of the cañon, and the largest is some fifty feet high. One series of them, on the shady side of the cañon, had been reserved for burial-places. Here, at a depth of three feet, Mr. Lumholtz dug out a number of bodies in a wonderful state of preservation, the saltpetre which is mixed with the disintegrated rock having for centuries preserved them, making them look like mummies. Several had their features, hair, and eyebrows perfect, and these were photographed. The hair is very slightly wavy, and softer than that of the ordinary Indian, almost silky in fact. They were small people, and reminded Mr. Lumholtz strikingly of the present Moqui village Indians. The Moquis, like the Zuñis, have a tradition that they came from the south. The same district abounds in mounds, some of which are very large. Mr. Lumholtz thinks that an explorer might find in these mounds a fine field for investigation. With his own limited force of men he was not able to make as extensive excavations as he wished to make; but still, a good deal of work was done. He unearthed a great many polished stone implements, about 300 jars, most of them decorated, and some in very odd shapes, and several specimens of a big stone wheel, and a stone cylinder fitting into it, probably used for some sort of game. The mounds contain houses, and, as usual, most of the relics are found near the dead bodies, which are always buried under the floor, partly under the wall. These people must have been there before the arrival of the cave and cliff dwellers, but who they were it would not yet be safe to say.

MESSRS. T. COOKE AND SONS, of Buckingham Works, York, have issued a new illustrated catalogue of telescopes, surveying and other optical instruments.

MESSRS. GURNEY AND JACKSON (Mr. Van Voorst's successors) hope to have ready for publication by the end of this year the first volume of "A Synonymic Catalogue of Lepidoptera-Heterocera," which Mr. W. F. Kirby, of the Zoological Department, British Museum, has been for some time engaged upon.

SIR J. D. HOOKER's well-known book of travels, "Himalayan Journals," has been reprinted in the Minerva Library series (Ward, Lock, Bowden, and Co.). It is reprinted from the first (unabridged) edition, with the omission of some of the appendices, which were only of limited general interest. Mr. Murray has supplied copies of the original woodcuts, many of them from drawings by the author.

A NEW Review, which will be partly scientific, is about to be issued at Rome. It is to be published twice in the month, and will be entitled *Natura ed Arte*.

THE admirable Harveian Oration recently delivered by Dr. W. H. Dickinson has just been published by Messrs. Longmans, Green, and Co.

PART 9 of Cassell and Co.'s "Universal Atlas" has just been issued. It contains a map of the Balkan Peninsula, another of China and Japan, and one of Japan alone, the first occupying a double page.

TWO communications upon phosphides of boron have been published by M. Moissan and M. Besson respectively in the most recent numbers of the *Comptes rendus*. M. Moissan has obtained two compounds of phosphorus and boron of the composition PB and P_3B_5, by the reduction of the new compound PBI_2 recently prepared by him (comp. NATURE, vol. xlv. p. 67) in a current of hydrogen gas. M. Besson, however, in July of this year published a note upon one of these compounds, PB, which he obtained by heating the compound $BBr_3.PH_3$ to the temperature of 300° C., and in the current number of the *Comptes rendus* calls M. Moissan's attention to the fact. These compounds of boron and phosphorus appear to be somewhat remarkable substances, and the following is a brief account of their mode of preparation and properties, as described by Messrs. Moissan and Besson. The curious compound PBI_2 is a substance crystallizing *in vacuo* in beautiful bright red crystals. When these crystals are heated in a current of dry hydrogen to a temperature of 450°-500°, three things happen: a small portion of the compound volatilizes unchanged, and forms an annular red deposit upon the cooler part of the tube; another portion loses iodine and yields a second sublimate, yellow in colour, of the other compound of phosphorus, boron and iodine, $(PBI)_2$, prepared by M. Moissan; the remainder of the PBI_2 becomes converted *in situ* into the normal phosphide of boron, PB. The heating of the PBI_2 is best effected in a U-shaped tube immersed in a bath of fused nitre. After the reduction is completed as far as possible, which is determined by the cessation of the evolution of vapour of hydriodic acid, the U-tube is removed from the bath, and the residual phosphide extracted, powdered rapidly, and again placed in the tube, and the reduction continued for a short time longer, in order to insure the removal of the las traces of iodine. The phosphide of boron thus obtained is a brown powder, very light in texture, and insoluble in every solvent which has yet been tried. In contact with oxygen the compound ignites at a temperature about 200°, and burns with a very brilliant flame, forming boric and phosphoric anhydrides. With chlorine gas it inflames at the ordinary temperature, producing boron trichloride and phosphorus pentachloride. Vapour of sulphur converts it into sulphides of boron and phosphorus. When thrown into a little fused nitre instant incandescence and deflagration occur. Its behaviour with nitric acid is characteristic; it immediately becomes incandescent, and moves rapidly to and fro over the surface of the acid, all the while burning with a most dazzling flame. It reduces concentrated sulphuric acid to sulphur dioxide. Fused potash decomposes it with evolution of phosphoretted hydrogen and formation of potassium borate. Sodium or potassium, in an atmosphere of hydrogen, react upon warming with great energy, the mass becoming white-hot. Magnesium, heated with the phosphide to 500°, also reacts with incandescence. Even silver and copper react violently upon heating with phosphide of boron. Vapour of water decomposes it at 400°, with production of boric acid and phosphoretted hydrogen. Heated to 300° in ammonia gas it takes fire, and burns with formation of nitride of boron and deposition of phosphorus.

THE second compound of boron and phosphorus, P_3B_5, was obtained by M. Moissan by heating the compound PB just described in a current of hydrogen to a temperature near 1000°. Under these circumstances a portion of the phosphorus is eliminated, and condenses in drops in the colder part of the tube, leaving the P_3B_5 in the form of a light brown powder, which is distinguished from the normal phosphide BP by its indifference to chlorine and nitric acid. It is much more stable than the normal phosphide, but is, like the latter compound, decomposed with incandescence by fused nitre.

THE additions to the Zoological Society's Gardens during the past week include a Formosan Fruit Bat (*Pteropus formosus*) from Formosa, presented by Mr. Thomas Perkins, F.Z.S.; a Patagonian Cavy (*Dolichotis patachonica*) from Patagonia, presented by Mr. H. H. Sharland, F.Z.S.; a Blotched Genet (*Genetta tigrina*) from South Africa, presented by Mr. Edmund R. Boyle; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. G. F. Hawker; a Little Grebe (*Tachybaptes fluviatilis*), British, presented by Mr. T. E. Gunn; a Tuatera Lizard (*Sphenodon punctatus*) from New Zealand, presented by Mr. W. King; a Brush-tailed Kangaroo (*Petrogale penicillata*) from New South Wales, purchased; three Carpet Snakes (*Morelia variegata*) from New South Wales, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE SECULAR ACCELERATION OF THE MOON AND THE LENGTH OF THE SIDEREAL DAY.—Laplace showed that the secular diminution of the eccentricity of the earth's orbit ought to produce in the longitude of the moon a term proportional to the square of the time, and which he determined as $+ 10''t^2$, where t is expressed in centuries. Adams and Delaunay have reduced this term to $+ 6''\cdot 11t^2$. From a discussion of eclipses Airy concluded that the coefficient of acceleration is as much as 12″ or 13″; and accepting this, the question arises as to the cause, other than that indicated by Laplace, which will account for the difference of $6''t^2$. This forms the subject of a paper by M. Tisserand in *Comptes rendus*, No. 20, 1891. Prof. Darwin found that the tidal action between the earth and the moon was sufficient to furnish an apparent acceleration equivalent to the required complement. The accompanying decrease in the earth's rotational velocity produces an apparent acceleration of $3''\cdot 8t^2$ in the case of Mercury, an amount which may make the longitude of the planet vary by as much as 15″ in a couple of hundred years. Since the observed transits of Mercury extend over more than two centuries, M. Tisserand has discussed them with the idea of determining whether the term $3''\cdot 8t^2$ is really indicated by them. He finds, however, that the extreme transits are not so well represented with the new term as without it, although the difference is not very great. This result, therefore, is unfavourable to the idea as to the variability of the sidereal day, or at least to a variation sufficient to reconcile the result of Airy's research with the calculations of Adams and Delaunay. This being so, it is concluded that the increase in the length of the day, produced by tidal action, has nearly the same value as the diminution which results from the contraction of the earth caused by secular cooling, and that, on account of the compensating action of the two effects, the length of the sidereal day remains very nearly invariable.

STATE OF SOLAR ACTIVITY.—Prof. Tacchini gives, in *Comptes rendus* for November 30, a *résumé* of solar observations made at the Royal Observatory of the Roman College during July, August, and September of this year. The number of days of observation were 31 in July, 31 in August, and 19 in September, and the results obtained are as follows:—

1891.	Relative frequency: of spots.	Relative frequency: of days without spots.	Relative magnitude: of spots.	Relative magnitude: of faculæ.
July	18·65 ...	0·00 ...	76·25 ...	82·03
August	8·84 ...	0·06 ...	49·06	70·81
September ...	17·52 ...	0·00 ...	114·45 ...	61·10

A comparison of these numbers with those determined in the preceding quarter shows that solar activity has sensibly increased, for the spotted surface has twice the area. It will be seen that the minimum magnitude of faculæ occurred at the time of a maximum of spots. The following are the results obtained for prominences:—

1891.	Number of days of observation.	Prominences. Mean number.	Mean height.	Mean extension.
			″	°
July	30 ...	8·37 ...	40·2 ...	1·4
August	30 ...	6·77 ...	41·0 ...	1·9
September... ...	23 ...	9·26 ...	41·4 ...	2·2

The number of prominences recorded is greater than during the preceding three months. The highest prominence (142″) was observed in August.

OBSERVATIONS OF μ CEPHEI.—Mr. J. E. Gore made some observations of the variable star μ Cephei, the "garnet star" of Sir William Herschel, between January 1888 and December 1890, which show that the variation of light is very irregular, and that the star sometimes remains for several months with little or no perceptible change of magnitude (Proc. Royal Irish Acad., January 26, 1891).

Astronomische Nachrichten, No. 3067, contains an account of the investigation, carried out by Herr Dr. Walter Wislicenus on the "Influence of Ring and Disk Blinds in Micrometic Measurements," in order to account for the following phenomenon. If one lifts a transit off its pillars and places it so that it does not interfere with the line of sight of the collimators, and then brings the central wires of each collimator exactly in coincidence, it is found that, by putting the meridional circle back again, and placing it in its vertical position with the apertures in the central cube open, coincidence of the wires no longer exists, but a slight displacement is noticed. It may be remembered that this question was raised at Greenwich as early as the year 1868, while in the two following years, from observations made in that interval, a correction of 0″·48 and 0″·58 was found for the difference of reading. In 1874 this discrepancy was accepted as real, and corrections for it were made, but no real origin for it was assigned. Mr. Turner, in the year 1886, also investigated this difference of reading, employing the collimators of the transit circle at Greenwich, and the numerical results obtained were given in vol. xlvi. p. 329, of the *Monthly Notices*. By using a wooden model of the central cube of the transit, he got essentially the same results as those given by the cube in the ordinary manner, but both were in discordance with the readings taken when nothing was interposed. To account for the difference he says: "The discrepancy is due to a real difference between the lines of collimation of the central and eccentric portions of the object-glasses of the collimators."

In Herr Dr. Wislicenus's experiments, six blinds of varying diameters were employed, and were placed on the cube of the Strassburg meridional circle to represent different central-cone apertures. He measured the difference between the readings taken with and without these blinds on five separate days, in the two positions, horizontal and vertical, of the collimator threads. To still further vary the method, he removed the meridional circle, and placed the blinds on the collimators, making another series of observations, the collimator threads being again in these two positions. From the above measurements he concluded (to state it very briefly): (1) that the differences obtained with the Greenwich circle are of a purely optical nature, and can be easily removed by making the aperture of the central cube somewhat larger than the full aperture of the collimators; (2) and also if the objective of a telescope be screened quite symmetrically by concentric rings or disks, or by such an arrangement as that in the Greenwich instrument, there occurs not only a variation in the focal image as regards sharpness and brightness, but there can also be found the same displacement. In discussing the observations and conclusions arrived at, he mentions that in the best objectives the same colour rays do not combine in a point on the optical axis, but in such a way that one does not obtain a focus but a focal line of unequal brilliancy, from the brightest point of which one deduces the focal plane of the lens; he then goes on to say that since the optical axis of the lens forms therefore an angle with that of the objective, the displacement of the brightest point of the focal line would not fall perpendicular on the focal plane of the lens, but one would have to observe it with the lens somewhat on one side, by this means one would be able to see its projection on the focal plane of the lens. Therefore, "by the existence of a centering-error the displacement of the focal image by the insertion of blinds before the objective would be explained."

THE *Annales* of the University Observatory in Vienna, vol. vii., contains all the observations of planets and comets made in the years 1887–89, with the Fraunhofer's, Clark's, and Grubb's refractors of apertures 16·2 cm., 30·1 cm., and 68·0 cm. respectively, together with the reduced results of the above. In addition to the work mentioned, the Grubb refractor was extensively employed in the study of the nebula in the Pleiades, special attention being given to the Merope nebula, which forms the chief topic of discussion in the interesting report towards the end of the volume; an excellent illustration also of the nebula itself is added, in which are shown all the fundamental stars with many others of smaller magnitude.

Of the other illustrations given, there are three very good pictures of the moon, taken with the same instrument. Plate I. is the result of an exposure of 6 seconds taken on an orthochromatic plate, and for sharpness and clearness is excellent. Plate II., which is an enlargement of a part of Plate I. enlarged four times is also very fine. Plates IV., V., and VI., contain drawings of comets and nebulæ, and are accompanied with descriptions of their peculiarities.

Altogether this volume is of a most interesting nature, and shows the result of a great amount of painstaking and useful work, which will be welcomed by all astronomers.

THE EASTERN TAURUS AND ANTI-TAURUS.

AT the meeting of the Royal Geographical Society, on Monday evening, the paper read was on the Passes of the Eastern Taurus and Anti-Taurus, by Mr. D. G. Hogarth.

The paper described the general characteristics, geographical and ethnographical, of the eastern half of the mountain system of Southern Asia Minor, and is based on experience gained by the author in the course of journeys in 1887, 1890, and 1891, undertaken under the auspices of the Asia Minor Exploration Fund, to which the Royal Geographical Society has been a generous contributor. In 1890, Prof. W. M. Ramsay was the head of the Expedition, and though in the other years the author was not accompanied by him, he followed lines which that great authority on Asia Minor had laid down. Mr. H. A. Brown (author of "A Winter in Albania"), the Rev. A. C. Headlam, of All Souls' College, and Mr. J. A. R. Munro, of Lincoln College, Oxford, took part in the expeditions in different years. The first object of the journeys was archæological, to carry on the brilliant work of Prof. Ramsay commenced in 1881, but the members of the expeditions have always taken geographical notes and observations in traversing the interior of Asia Minor, about many parts of which less is known in modern than was known in ancient times. In following old trade-routes across the mountains, the explorers have traced the modern tracks, for the limits of ancient and modern geography are very often not to be distinguished in Asia Minor. Much of the peninsula is a land of the dead, but much also possesses great interest in the present, and, may be, will acquire an interest of a different kind for England in the near future. It has been explored by many travellers, from Pococke, Hamilton, Leake, and Ainsworth, to the archæologists who have penetrated it in different directions during the past twenty years, and the trained surveyors, led by Sir Charles Wilson, who did so much geographical work in it ten years ago. But Asia Minor is very large, often very difficult to traverse, and of very varied character, as is to be expected in the meeting-place of so many civilizations and faiths, ancient and modern. Much has yet to be done before western geographers can claim even a superficial knowledge of its whole area, and many parts have never been visited by any explorer at all.

The first district described is the wild mountainous region between the beautiful lakes of Egerdir and Beysheher, remarkable for the absence of passes, for the great gorge of Eurymedon, and for the primitive character of the indigenous population who live cut off from the world. Not less noteworthy are the extraordinary ruins of the Pisidian city of Adada, which exist high up among the hill-tops, and are now called *Kara-Bavlo*, a name which recalls that of St. Paul, and probably is derived from a great church dedicated to the Apostle in commemoration of a sojourn on his way from Perga to Antioch in 45 A.D. These ruins preserve the most perfect specimen of an Anatolian city of Roman days. Passing by the sites of Lystra and Derbe, the Low Taurus is reached, a marked depression between the high inter-lacustrine ranges and the Bulgar Dagh, which begins about 70 miles west of the Cilician Gates (Gulek Boghaz). The waterless, arid character of the northern, and beautiful scenery of the southern slopes, especially in the Calycadnus valley, are described in connection with the routes radiating from Karaman. The remarkable ruins of the monastery of Koja Kalessi, which contain a very perfect church of the early fifth century at the latest, and of the city of Coropissos, add archæological interest to this section of the Taurus. The eastern part of this region is a veritable Pompeii, where Roman cities, villages, and roads have been left to decay in a deserted country.

The high Taurus is reached near Eregli. The famous defile known as the "Cilician Gates" has been often described, but not so the important passes further east, from Sis to Hadjin and Gyuksun; from Marash to Gyuksun, Zeitun, and Albistan; and from Adiaman to Besni and Malatia. The Eastern Taurus is a region of great beauty, richly wooded, and traversed by the tremendous cañons of the Samanti, the Saros, and the Jihan, not passable even on foot. Whenever a railway is made from Asia Minor towards the Euphrates, it will take the gorge of the latter river, which in ancient times was rendered possible for a road. The ethnographical and historical interest of this region is very great, as it formed the refuge of the last independent Armenians of Cilicia, whose robber-towns, Hadjin and Zeitun, are described by the author. Of late their exclusive possession has been disputed by Circassians and Kurds, the latter retaining curious traces of their pre-Islamite rites and customs.

Lastly, the principal passes into the Anti-Taurus from the west, and out on the east in the direction of the Euphrates, are briefly noticed. The Anti-Taurus district is one of the most curious in Asia Minor; man deserted it almost entirely from the eleventh century until less than a century ago, when nomadic Avshar and Kurds penetrated to its remote and lofty valleys. Thus has been preserved so much of the great Roman military road to the Euphrates in the valleys of the Saros and Gyuk Su, with a series of milestones recording its many restorations; to the same cause we owe the interesting ruins of Comana, and "Hittite" monuments, recalling very early days, when a great trade-route, afterwards identical with the Royal Persian road, already took this line. Of different but equal interest are the modern inhabitants, nomadic Avshar, and half-troglodyte Kurds, nominally Musulmans, but really worshippers of other gods than that of Islam; and newly-imported Circassians, settled near troublesome Armenian strongholds as a menace and a check. The medley of races in this remote region, for whose control the Turks seem able to make no adequate provision, suggests speculations as to the possible future of race-supremacy in the Ottoman Empire.

THE ZOOLOGY AND BOTANY OF THE WEST INDIA ISLANDS.[1]

THIS Committee was appointed in 1887, and it has been reappointed each year until the present time.

During the past year Mr. F. DuCane Godman, F.R.S., has continued to employ a collector in the island of St. Vincent, and owing to the valuable assistance thus afforded to the Committee it has been possible to complete the exploration of this island. The collections in zoology are very extensive, and those in botany extend to the whole of the phanerogams and the vascular cryptogams. No expense has been incurred by the Committee in regard to any of these collections in St. Vincent.

The services of Mr. R. V. Sherring, F.L.S., were accepted, as mentioned in the last report, to make botanical collections in the island of Grenada. He left this country in October last, and returned after seven months' absence in June last. Mr. Sherring has forwarded to this country large collections, consisting for the most part of vascular cryptogams, and these are now in course of being determined at Kew. A detailed report on the various collections in zoology and botany received during the past year is given below.

At the present time Mr. Herbert H. Smith, the collector employed by Mr. Godman, is making collections in zoology in the island of Grenada. This is the most southerly of the chain of islands intended to be explored by the Committee. When this island is completed, the Committee will have been engaged in investigating the fauna and flora of most of the islands in the Lesser Antilles lying between Martinique and Trinidad. The islands in which collections have so far been made consist of Dominica, St. Lucia, Barbados, St. Vincent, the Grenadines, and Grenada.

Zoology.—Since the last report collections have continued to be received from St. Vincent by Mr. Godman. The work of sorting and arranging these collections has been begun. The arthropods are already completed, and the larger part of the insects is mounted and prepared for despatch to the specialists who have been engaged to work them out.

For this purpose the Committee have been so fortunate as to obtain the assistance of the following naturalists: Herr Hofrath Brunner von Wattenwyl for the Orthoptera; Prof. Riley for the Rhynchota; Mr. Howard for the parasitic Hymenoptera; Prof. S. W. Williston for the Diptera; Prof. Aug. Forel for the Ants; Lord Walsingham for Lepidoptera, part; F. D. Godman and O. Salvin for Lepidoptera, part; D. Sharp for Coleoptera; M. Simon for Spiders generally; Mr. G. W. Peckham for Attidæ. The Committee have undertaken to procure publication of the memoirs that may be received from these *savants*.

A small collection of specimens made by Dr. H. A. Alford Nicholls, F.L.S., local secretary to the Committee in the island of Dominica, was received in May last. This consisted of nine mammals, one lizard, one snake, five fishes, one *Ascalaphus*, twelve Longicornia, two Passalidæ, and five Lamellicornia. Besides these Dr. Nicholls sent from the island of Tobago four of the peculiar nests of the yellow-tailed bird of that island (*Cassicus cristatus*). These birds usually build their nests depending from isolated branches of the silk-cotton tree (*Eriodendron anfractuosum*), and they look like huge fruits waving in the wind.

A small collection of Lepidoptera was received in November last from Captain Hellard, R.E., local secretary to the Committee in the island of St. Lucia. The mounted specimens in this collection arrived in bad order, owing to the pieces of camphor getting loose in the boxes and breaking the greater part of them, including almost the whole of the *Sphingidæ*.

Mr. John C. Wells, who has devoted attention to the ornithology of Grenada, has kindly consented to act as a local secretary for that island.

Botany.—Of the botanical collections received from St. Vincent the vascular cryptogams have been determined by Mr. J. G. Baker, F.R.S., and an accouut of them, with two plates, printed in the *Annals of Botany*, vol. v. (April 1891) pp. 163–172. Amongst the ferns the most striking novelty is a new species of *Asplenium*, named *A. Godmani*, Baker (pl. xi.), found in damp forests at the extreme top of Morne à Garou. Other new species are *Hymenophyllum vincentinum*, Baker (pl. x.), and *Acrostichum* (*Elaphoglossum*) *Smithii*, Baker. The total number of vascular cryptogams found recently in St. Vincent amounts to 168 species. Most of these are widely spread through tropical America, and only four are endemic. In addition to the above a new species of *Hepaticæ*, also from St. Vincent (*Kantia vincentina*, C. H. Wright), was described in the *Journal of Botany*, vol. xxix. (April 1891), p. 107.

Of the phanerogams from St. Vincent and some of the Grenadines the work of determining these is being carried on as expeditiously as circumstances permit. The collection is a very large one, and the results so far attained are contained in the following memorandum prepared by Mr. R. A. Rolfe:—

The flowering plants have been determined as far as the end of Rutaceæ. Those from St. Vincent number slightly over a hundred species, of which about thirty, consisting for the most part of common West Indian plants, were not previously recorded from the island. The most interesting plant is a species of *Trigyneia* (apparently new), a small tropical American genus of Anonaceæ not hitherto detected in the West Indies. A *Clusia* and a species of *Tetrapterys*, which cannot be identified, may also prove new. The remainder have been fully determined. The three most interesting of these are *Norantea Jussiæi*, Tr. and Pl., previously known only from Guadaloupe and Dominica; *Zanthoxylon microcarpum*, Griseb., from Dominica and Trinidad; and *Z. spinosum*, Sw., from Dominica, Jamaica, and Cuba. The composition of the flora of the Lesser Grenadines, situated between St. Vincent and Grenada, was previously almost unknown. The plants hitherto determined are as follows:—From the island of Bequia, 34 species; from Mustique, 18; from Canouan, 5; and from Union, the nearest to Grenada, 5. They are, without exception, common West Indian plants, and are all also natives of St. Vincent. From the results hitherto obtained it seems clear that the flora of the Lesser Antilles is tolerably uniform throughout, although the larger islands of Dominica, Martinique, St. Lucia, and possibly St. Vincent, appear to have each a very small endemic element.

The collections made by Mr. Sherring at Grenada consist of nearly 6000 specimens of vascular cryptogams and about 1000 specimens of phanerogams. The number of species of ferns is about 140, and of these two are new, viz. *Alsophila Elliottii*, Baker, and *Acrostichum Sherringii*, Baker. The phanerogams have not yet been worked out. Sixty species of ferns were previously known from Grenada from collections made by Mr. G. R. Murray, F.L.S., and Mr. W. R. Elliott. Mr. Sherring has increased this number to 140. The species of greatest interest, other than those known to be new, are *Asplenium Godmani*, Baker, recently found in St. Vincent; *Polypodium Hartii*, Jenman, first described in 1886, and known only in the mountains of Jamaica and Dominica; and *Acrostichum Aubertii*, widely spread in continental America, but new to the West Indies. Other interesting plants collected by Mr. Sherring are *Schizæa fluminensis*, Miers, new to the West Indies, but believed to be only a shade variety of *S. dichotoma*, and *Danæa polymorpha*, Leprieur, a critical form of which but little is known.

An account of vascular cryptogams collected at Grenada is in course of being prepared for the *Annals of Botany*.

Mr. Sherring has prepared an interesting report on the flora of Grenada, and this will prove of great interest to students of West Indian botany.

A collection of plants was received from Dr. Nicholls at the same time as the specimens in zoology already noticed. These consisted of fifty-six species of vascular cryptogams—all of them, were, however, well-known West Indian plants—and a small number (175 numbers) of phanerogams. The latter have not yet been determined.

The Committee recommend their reappointment, with the following members: Dr. Sclater, Mr. Carruthers, Prof. Newton, Mr. Godman, Dr. Günther, and Dr. Sharp. The Committee also recommend that the grant of £100 placed at their disposal, but not expended during the current year, be renewed.

[1] Fourth Report of the British Association Committee, consisting of Prof. Flower (Chairman), Mr. D. Morris (Secretary), Mr. Carruthers, Dr. Sclater, Mr. Thiselton-Dyer, Dr. Sharp, Mr. F. DuCane Godman, Prof. Newton, Dr. Günther, and Colonel Feilden, appointed for the purpose of reporting on the present state of our knowledge of the Zoology and Botany of the West India Islands, and taking steps to investigate ascertained deficiencies in the Fauna and Flora.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. A. E. Shipley, Demonstrator of Comparative Anatomy, has been appointed Secretary to the Museums Syndicate; and Mr. S. F. Harmer, Demonstrator of Invertebrate Morphology, Superintendent of the Museum of Zoology, in the room of Mr. J. W. Clark.

Dr. William Ewart and Mr. Frederick Treves have been appointed Additional Examiners for the Third M. B. Examination, for which the number of candidates is unusually large.

Candidates for Lord Walsingham's Gold Medal in Biology and Physiology are requested to send in their essays to Prof. Newton by October 1, 1892.

An interesting report on the course of study pursued in Cambridge by the Local Lecture students during the Long Vacation, 1891, appears in the *Reporter* of December 8. Scientific courses on invertebrate palæontology, chemistry, physics, and physiology were given with success in the University Laboratories; while single lectures, with the object of inspiring interest in other departments, were given by Dr. Hill, Dr. D. MacAlister, and Prof. Darwin. Courses in general literature and art were also arranged, and the result of the whole is deemed by the Syndicate so satisfactory that they propose to regard the Long Vacation scheme as part of their regular work. Forty-seven students took advantage of the facilities offered by the University for acquiring a closer knowledge of the subjects they had commenced under the University Extension Lectures.

It is proposed that two new Syndicates shall be appointed—the first, to be called the Engineering Laboratory Syndicate, is to make arrangements for the further development of the Engineering School in the University, and in particular to endeavour to raise funds for its adequate endowment; the second is to consider the establishment of an Honours Examination in Mechanical Science.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for June 1891 contains:—On the renal organs of certain Decapod Crustacea, by W. F. R. Weldon (plates xxi. and xxii.). It would appear that the nephro-peritoneal sacs of the Decapoda should be regarded rather as enlarged portions of a tubular system, such as that found in Mysis and in the Thalassinidæ, than as persistent remnants of a "cœlomic" body-cavity, into which tubular nephridia open.—On the nephridium of Lumbricus and its blood-supply, with remarks on the nephridia in other Chætopoda, by Dr. W. Blaxland Benham (plates xxiii. to xxv.). In this memoir the author settles the nomenclature of the parts of the nephridium and the course of the various regions; details the structure of these regions in Lumbricus; institutes a comparison with the nephridium in other genera; describes the nephrostome or funnel in *Perichæta malamaniensis*, n.sp., and some other genera; and describes and figures the vascular supply of the nephridium in Lumbricus and in Arenicola.—Notes on the Naidiform Oligochæta, containing a description of new species of the genera Pristina and Pterostylarides, and remarks upon cephalization and gemmation as generic and specific characters in the group, by Dr. A. Gibbs Bourne (plates xxvi. and xxvii.).—On *Pelomyxa viridis*, sp.n., and on the vesicular nature of protoplasm, by Dr. A. Gibbs Bourne (plate xxviii.). This new species of Pelomyxa was found in the mud of a small tank in the neighbourhood of the Madras Presidency College; it would seem to be about the largest known species of the Lobosa, spread out specimens average one-third of an inch in diameter; the vesicles contained chlorophyll, and were numerous; the protoplasm was densely packed with bacteria, the "crystals" of Greef; the pseudopods were coarse and blunt; no reproductive processes were noted; nuclei and nucleoli were present in numbers.—On the medusæ of *Millepora murrayi*, and on the gonophores of Allopora and Distichopora, by Dr. Sydney J. Hickson (plates xxix. and xxx.). From specimens from Torres Straits, preserved by Prof. Haddon, the author has determined that the ampullæ described in the hard parts of this Millepora by Quelch are the cavities containing male medusæ. The medusa of Millepora is a transformed zooid—that is, it is not from the first modified to bear the spermarium, but it is an ordinary zooid of the colony changed into a medusa after the migration of spermospheres into its ectoderm, which are subsequently developed there; these medusæ escape from the ampullæ before the spermatozoa are matured. The male gonophores of Distichopora differ from those of Allopora, but the female gonophores of these genera closely resemble one another. The gonophores of the Hydrocorallinæ and Hydromedusæ are carefully compared; those of the former are not degenerate medusæ.—On a red pigment-forming organism, *Bacillus corallinus*, by C. Slater (plate xxxi.).

October 1891 contains:—On immunity against microbes, by Dr. Armand Ruffer, Part 2 (plates xxxxii. and xxxiii.). While the first part of this memoir treated of the struggle which takes place in the healthy body between micro-organisms and amœboid cells, this part details what happens where these organisms have found their way into the tissues of animals. It would be impossible to do justice to the contents of this valuable memoir by an abstract.—On the formation and fate of the primitive streak, with observations on the archenteron and germinal layers of *Rana temporaria*, by Dr. A. Robinson and R. Assheton (plates xxxiv. and xxxv.). The primitive streak is formed in the frog by concrescence of the lips of the blastopore from behind forwards; the ventral moiety of the primitive streak, shortly after the perforation of the anus, ceases to exist and splits up; the dorsal moiety becomes folded upon itself, like and along with the neural plate, and becomes separated from the skin; it gives rise to the whole of the tail with the exception of the greater part of the skin.—On some points in the histology and development of *Myriothela phrygia*, by W. B. Hardy (plates xxxvi. and xxxvii.).—On the structure of an earthworm allied to Nemertodrilus, Mich., with observations on the post-embryonic development of certain organs, by Frank E. Beddard (plates xxxviii. and xxxix.).—On some points in the development of *Scorpio fulvipes*, by M. Laurie (plate xl.). The development of this form adds another to the numerous types of development in the Arrachnida; it is, as shown by its mode of nutrition, a highly specialized form. There is no doubt that the type of development represented by Euscorpius is the more primitive of the two. The chief arguments in favour of this are the remarkable facts of the formation in *Scorpio fulvipes* of a rudimentary amnion, and the formation of yolk-spheres in the earlier stages, and a mass of yolk round which the gut is formed.—Abstract of Maupas's researches on multiplication and fertilization in Ciliate Infusorians, by Dr. Marcus M. Hartog.—On the occurrence of pseudopodia in the Diatomaceous genera Melosira and Cyclotella, by J. G. Grenfell (plate xli.). The author states that he has found pseudopodia in *Cyclotella kutzingiana*, and in one or two small species of Melosira. "At Heytesbury, in Wiltshire, the River Wiley and the brooks were found full of a Melosira in small isolated frustules, with long delicate pseudopodia; a good set of Cyclotellas with pseudopodia were found at Kew Gardens." In the large pond in the gardens of the Botanical Society of London, frustules of Melosira gathered with some specimens of *Archerina boltoni* were found with these pseudopodia; sometimes they were easily seen for a part of their length with a 1/8 object-glass, but in some cases, as in the diatoms from Kew, "they are generally invisible, even when specially looked for." These pseudopodia are best seen on "well dried material," they are fairly stiff, and are non-retractile to ordinary observation. In length they vary, in Cyclotella from two and a half to six times the width of the valves; they are very permanent, in specimens kept in water they remained apparently unchanged for months; they are generally fairly straight, but sometimes they branch and sometimes two or three spring from a short thickened base. "As to the use of these pseudopods, and the question why other Diatoms do not have them, the chief point to be remembered is that these little Melosiras and Cyclotellas occur mainly as isolated frustules, and are without the power of locomotion. Under these circumstances the pseudopodia serve the purposes of protection, means of attachment, and floats." The author says: "facts point conclusively to the substance of these pseudopodia being protoplasm." It is quite probable that "some kind of cuticle is secreted by the protoplasm." As to the possibility of these growths not being pseudopodia at all, he combats the idea, and institutes a comparison between them and the radiating structures met with in Archerina (the reference to Prof. Ray Lankester's description of this very interesting form should be *Q. J. M. Sc.*, vol. xxv., 1885, p. 61), but it will be remembered that Prof. Ray Lankester refers to the "delicate but stiff filaments" in his description of Archerina, and only uses the term pseudopodia in a conventional sense. As yet we are not convinced by a perusal of Mr. Grenfell's paper that the Diatoms possess pseudopodia in any sense of this term, or that they have any affinities with the Heliozoa.—A very ably written review, signed by George Bidder, on "Dendy's Monograph of the Victorian Sponges, Part I.," which has just been published at Melbourne, concludes this part and volume xxxii. (N.S.) of the *Journal*. The first part of Dr. Dendy's monograph is devoted to the account of the Calcareous Sponges, a group on which Mr.

Bidder has himself been working at Naples for the last five years. His appreciatory remarks on Dendy's researches prove how much of interesting and new matter lies in manuscript in the laboratory at Naples, and leads us to express the hope that Mr. Bidder will soon follow the example of his senior, and give us a monograph of the Calcarea Homocœla of the Gulf of Naples; with more details on the glandular ectoderm.

Travaux de la Société des Naturalistes de St. Pétersbourg, Section de Zoologie et de Physiologie, tome xxi., livr. 1 (Russian).—On the influence of temperature, and the distance from the section of a nerve, on its electrical irritability, by B. F. Verigo.—Observations on the *Araneina*, by V. Wagner.—The minutes of proceedings contain several interesting notes: namely, a list of the Bryozoa of the Murman coast of Russia, by M. Khvorostansky, containing eighty-one species; on the blood of some invertebrates, by V. Wagner, from which it appears that it always contains two different kinds of cells—the granulous and coloured ones, and the amœboid ones or leucocytes, besides some other cells which, however, must be considered as derived from the above two kinds.—M. Shimkevitch's remarks on the artificial incubation of ostriches in the ostrich park at Heliopolis are also worth mentioning.

Bulletin de la Société des Naturalistes de Moscou, 1891, No. 1.—On the group of the sillimanite and the part played by aluminium in the silicates, by W. Wernadsky (in Russian, summed up in French). The paper contains, besides the description of the experiments already published in the *Comptes rendus*, a discussion of the facts, which brings the author to the following conclusions: the compounds of silicon with aluminium have an acid reaction; they may be embodied in one group, that of the sillimanite. Some of them are hydrates, and some others are salts of these, or of other possible anhydrides. Polymorphic varieties arise in this group with the change of physical conditions, without any perceptible change in the chemical composition.—On the morphology and classification of the Chlamydomonads, by Prof. Goroshankin (in German, with three coloured plates); being a full monograph on the family, in which the following new species are described: *Chlamydomonas De-Baryana*, *C. Perty*, *C. Steinii*, *C. Kuteinikowi*, *C. reticulata*, and *C. Ehrenbergii*.—On some peculiarities in the development and the structure of the skull of *Pelobates fuscus*, by A. N. Sewertzow.—Note on the *Hipparion crassum*, by Marie Pavloff (French).—On the fossil plant-bearing deposits of East Russia and Siberia, by C. Kosmovsky (in French). The close similarity between the supposed Jurassic fresh-water deposits of East Russia and Siberia and the "Artinsk" series is briefly indicated.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 19.—"On the Loci of Singular Points and Lines which occur in connection with the Theory of the Locus of Ultimate Intersections of a System of Surfaces." By M. J. M. Hill, M.A., Sc.D., Professor of Mathematics at University College, London. Communicated by Prof. Henrici, F.R.S.

Introduction.

In a paper "On the c- and p-Discriminants of Ordinary Integrable Differential Equations of the First Order," published in vol. xix. of the Proceedings of the London Mathematical Society, the factors which occur in the c-discriminant of an equation of the form $f(x, y, c) = 0$, where $f(x, y, c)$ is a rational integral function of x, y, c, are determined analytically.

It is shown[1] that if $E = 0$ be the equation of the envelope locus of the curves $f(x, y, c) = 0$; if $N = 0$ be the equation of their node locus; if $C = 0$ be the equation of their cusp locus, then the factors of the discriminant are E, N^2, C^3.

The object of this paper is to extend these results to surfaces.

PART I.—*The Equation of the System of Surfaces is a Rational Integral Function of the Co-ordinates and one Arbitrary Parameter.*

When there is only one arbitrary parameter, each surface of the system intersects the consecutive surface in a curve, whose equations are the equation of the surface and the equation obtained by differentiating it with regard to the parameter. (These equations will be called the fundamental equations in this part.) Hence each surface touches the envelope along a curve. It is known that the equation of the envelope may be obtained by eliminating the parameter from the fundamental equations and equating a factor of the result to zero. But it frequently happens that there are other factors of the result (or discriminant) which, when equated to zero, do not give the equation of the envelope.

These factors are connected with loci of singular points. If each surface have one singular point, the locus of all the singular points of the surfaces of the system is a curve. Its equations, therefore, cannot be found by equating a factor of the discriminant to zero. But if each surface of the system have upon it a nodal line, then the locus of the nodal lines of all the surfaces is a surface, and its equation may be found by equating to zero a factor of the discriminant.

The singular points in space, the form of which depends only on the terms of the second order, when the origin of co-ordinates is taken at the singular point, are:—

(i.) The conic node.
(ii.) The biplanar node or binode.
(iii.) The uniplanar node or unode.

It is shown that a surface cannot have upon it a curve at every point of which there is a conic node. Hence there are two varieties of nodal lines to be considered; the first, being such that every point is a binode, may be called a binodal line; and the second, being such that every point on it is a unode, may be called a unodal line.

It is shown that if $E = 0$ be the equation of the envelope locus, $B = 0$ the equation of the locus of binodal lines, $U = 0$ the equation of the locus of unodal lines, then the factors of the discriminant are, in general, E, B^2, U^3, respectively.

This is the general theorem, but it is assumed in the course of the investigation, when the discriminant is being formed, that the fundamental equations are satisfied by only one value of the parameter at each point on the envelope locus or on a locus of binodal or unodal lines.

The investigation is accordingly carried a step further, and it is shown that if the fundamental equations are satisfied by two equal values of the parameter at points on an envelope locus, or on a locus of binodal or unodal lines, the factors of the discriminant are E^2, B^3, U^4, respectively.

The geometrical meaning of the condition that the fundamental equations are satisfied by two equal values of the parameter in the case of the envelope is that the line of contact of the envelope with each surface of the system counts three times over as a curve of intersection, instead of twice as in the ordinary case. The meaning of the condition in the case of the loci of singular lines is that each of these loci is also an envelope.

PART II.—*The Equation of the System of Surfaces is a Rational Integral Function of the Co-ordinates and two Arbitrary Parameters.*

When there are two arbitrary parameters in the equation of the system of surfaces, the equation of the locus of ultimate intersections is found by eliminating the parameters between this equation and the two equations obtained by differentiating it with regard to the parameters. (These equations will in this part of the investigation be called the fundamental equations.)

In general the locus of ultimate intersections is a surface. The exceptional cases in which it is not a surface are enumerated at the end of the paper. These include the case where the equation of the system of surfaces is of the first degree in the parameters. Hence it will be supposed that the degree of the equation of the system of surfaces in the parameters is above the first.

In general, the locus of ultimate intersections possesses the envelope property, and the equation of the envelope is determined by equating the discriminant, or a factor of it, to zero.

If factors of the discriminant exist which, when equated to zero, give surfaces not possessing the envelope property, then these surfaces are connected with loci of singular points.

Now the locus of singular points of a system of surfaces whose equation contains two arbitrary parameters is in general a curve. Hence its equations cannot be determined by equating to zero a factor of the discriminant.

But if every surface of the system have a singular point, then *in general* its co-ordinates may be expressed as functions of the two parameters of the surface to which it belongs. Hence the locus of the singular points is a surface. It will be proved that it is a part of the locus of ultimate intersections. Hence its

[1] The theorem was originally given by Prof. Cayley, in the *Messenger of Mathematics*, vol. ii., 1872, pp. 6–12.

equations can be obtained by equating to zero a factor of the discriminant.

Let $E = 0$ be the equation of the envelope locus,
$C = 0$ be the equation of the conic node locus,
$B = 0$ be the equation of the biplanar node locus,
$U = 0$ be the equation of the uniplanar node locus.

Now at any point on the locus of ultimate intersections—

(I.) *There may be one system of values of the parameters satisfying the fundamental equations.*

In this case there may be envelope, conic node, or biplanar node loci; and the corresponding factors of the discriminant are E, C^2, B^3 respectively.

(II.) *There may be more than one system of distinct values of the parameters satisfying the fundamental equations.*

In this case the effect of the distinct values is additive. Thus if there be p systems of values at a point on the envelope locus, the factor E would occur to the pth power.

(III.) *Two or more systems of values of the parameters satisfying the fundamental equations may coincide.*

The results must be stated differently in the cases (α) where the degree in the parameters of the equation of the system of surfaces is greater than two; (β) where the degree in the parameters of the equation of the system of surfaces is two.

In the case (α) it will be shown that there may be envelope loci in which the envelope has stationary contact with each surface of the system; conic node loci, which are also envelopes; biplanar node loci, in which the edge of the biplanar node always touches the biplanar node locus; and uniplanar node loci: and the corresponding factors of the discriminant are E^2, C^3, B^4, U^6 respectively.

The case (β) always falls under the next case—

(IV.) *The values of the parameters satisfying the fundamental equations may become indeterminate.*

If the equation of the system of surfaces be of the second degree in the parameters, and the analytical condition hold which expresses that the fundamental equations are satisfied by two coinciding systems of values; then this condition requires to be specially interpreted. For now the second and third fundamental equations are of the first degree in the parameters, so that if they are satisfied by two coinciding systems of values, they must be indeterminate.

It is, however, possible to determine a *single* system of values of the parameters satisfying them. In this case the three surfaces represented by the fundamental equations intersect in a common curve (which is fixed for fixed values of the parameters) lying on the locus of ultimate intersections; whereas in the previous cases they intersect in a finite number of points lying on the locus of ultimate intersections.

The surface of the system, corresponding to the fixed values of the parameters, touches the locus of ultimate intersections along the above-mentioned curve.

In general, there are *two* conic nodes of the system at every point of the locus of ultimate intersections. The parameters of the surfaces having the conic nodes are determined by two quadratic equations, called the parametric quadratics; and in general the roots of *each* parametric quadratic are *unequal*. In this case the corresponding factor of the discriminant is C^2. If the roots of *both* parametric quadratics are *equal*, the two surfaces having conic nodes are replaced by one surface having a biplanar or uniplanar node. In this case the corresponding factors of the discriminant are B^3, U^4, respectively.

If the parameters of *one* of the surfaces having a conic node become *infinite*, this surface may be considered to disappear, and there is but one conic node at each point of the locus of ultimate intersections. In this case the corresponding factor of the discriminant is C^2.

If the parameters of *both* surfaces having conic nodes become *infinite*, both these surfaces may be considered to disappear, and the locus of ultimate intersections is an envelope locus (touching each surface of the system along a curve). In this case the corresponding factor of the discriminant is E^3.

If the parameters of *both* surfaces having conic nodes become *indeterminate*, then there are at each point an infinite number of biplanar nodes, and each surface of the system has a binodal line lying on the locus of ultimate intersections. In this case the corresponding factor of the discriminant is B^4.

Physical Society, November 20.—Prof. W. E. Ayrton, F.R.S., President, in the chair.—Dr. Philippe A. Guye gave a short account and discussion of the various forms which have been given to the general equation expressing the behaviour of liquids and gases under different conditions of volume, temperature, and pressure, by Van der Waals, Clausius, Sarran, Violi, Heilborn, and Tait. He first considered the equation of Van der Waals, which, although only an approximation to the true one, may be made to lead to numerous important deductions. He then showed that, of the various more exact formulæ proposed, that of Sarran is the simplest, and may be used with less expenditure of time and trouble than any of the others. In conclusion, he insisted on the necessity of experimental researches as the only means of arriving at a definite conclusion as to which of the various formulæ is the true one; such researches should involve determinations, as exact as possible, of the critical constants, and of isotherms at high temperatures and great pressures. Prof. Ramsay inquired whether the constants in the formula of Clausius had any physical meaning, or were they merely numbers? M. Guye, in reply, said that, although *some* of the constants in the improved formulæ had physical interpretations, Van der Waals's equation was the only one in which *all* the constants had precise physical significations. Prof. Rücker said it was only necessary to look at the formulæ to see how important a factor Van der Waals's expression had been in later developments of the subject. Although it did not agree with experiment under all conditions, particularly at small volumes, yet it was a close approximation over a considerable range, and was the only formula in which all the constants had definite physical meanings. Prof. Tait had pointed out that the number of constants were too few to fully represent the facts, for, by following Andrews's reasoning, he had shown that about the critical point a straight line cuts the isotherm in five points. Nevertheless, during the last twenty years all the so-called improved formulæ were modifications of Van der Waals's expression, and this, he thought, showed how valuable the original formula was. Prof. Fitzgerald said he once tried how far Clausius's formula agreed with the experimental results published by Messrs. Ramsay and Young, and after several months' work, relinquished it on account of the tremendous labour involved. He thought that such complicated formulæ retarded rather than advanced science; simple ones (even if less accurate) were likely to lead to greater advancement. Prof. Carey Foster remarked that the expression $pv = RT$, which is nearly true for gases, was the starting-point of all subsequent advances. Van der Waals had arrived at a still closer approximation by taking into account the volume occupied by the particles and their mutual pressure. The President said Van der Waals's memoir had been adversely criticized because of its supposed insufficient recognition of Andrews's investigations on the subject. Better acquaintance with the work had, however, shown this criticism to be undeserved.—Dr. C. V. Burton read a paper on a new theory concerning the constitution of matter. It is assumed that it is possible to have in the ether a distribution of strain which is itself in equilibrium. Such a distribution is called a "strain-figure." An atom is looked upon as an aggregation of strain-figures, the possible *varieties* of strain-figures (and hence of atoms) being limited by the conditions of equilibrium, and the *sizes* of possible strain-figures dependent on the coarse-grainedness of the turbulent motion or other structure of the ether. The motion of matter is considered to be merely the transference of a strain distribution from one portion of the ether to another. This the author illustrated by causing a loop to travel along a rope, the loop being regarded as a strain distribution which is propagated along the rope, whilst the rope itself is not transferred. Such transference may occur without encountering any resistance, and the strain-figure will retain the same form, provided the velocity is small compared with that at which gravitation is propagated. The equations of motion of a strain-figure are deduced, and are shown to be identical with those of ordinary matter, provided certain conditions of symmetry are realized. It is also shown under what conditions an atom consisting of strain-figures would have a finite number of degrees of freedom, and some attempt is made to examine how gravitation and other attractions might follow from a distribution of stress in the strained ether. An inquiry is also made into the reason why elements have fixed properties, and their transmutation is discussed. Prof. Fitzgerald, referring to the elastic-solid theory of the ether, said Sir W. Thomson's more recent papers had thrown considerable doubt upon it. The propagation of strain-figures was, he thought, a case of wave motion. In his lectures he had likened the passage of matter through space to that of a drop of water through ice, the ice in front melting, and the rear of the drop freezing as the liquid state progressed. Many points raised in the paper were, he said, very interesting, and the suggestion that the discrete nature of atoms is the result of the coarse-grainedness of matter, very good. On the other hand, he considered the static treatment of strain-figures improper, for the ultimate conditions must be kinetic. Dr. O. Lodge agreed with Prof. Fitzgerald in regarding the motion of the loop along the rope as a wave motion whose velocity of propagation is equal to that of the loop. A similar case occurs when a ring of rope is spinning, and has a pulse impressed on it at one point, for the pulse travels at the same speed as the rope.—A paper on a permanent magnetic field, by Mr. W. Hibbert, was postponed until next meeting.

Royal Microscopical Society, November 18.—Dr. R. Braithwaite, President, in the chair.—A special meeting was first held, at which certain alterations in the by-laws were proposed by the Council, and accepted by the Fellows. The ordinary meeting was then constituted.—Mr. C. L. Curties exhibited and described a small heliostat made on the lines laid down by Mr. Comber. It was simple and effective, and was adapted for use in any latitude between 15° and 70°.—Mr. J. W. Gifford read a paper on the resolution of *Amphipleura pellucida*. Mr. Gifford said he had examined a frustule of *A. pellucida* with sodium light illumination, that being the most convenient form of monochromatic light at the time. Under this light *A. pellucida* unmistakably showed dots, which became more marked as the frustule was shifted to the side of the field of vision. The question then arose as to the possibility of photographing the object by the light of the sodium flame, and plates treated with an erythrosine bath were used. It occurred to him that a trough containing a solution of iron perchloride used as a screen would cut off all the blue end of the spectrum, and also some of the green, leaving only the green yellow, yellow and red; but on the other hand, he found the erythrosine plates were only sensitive as far down as the yellow, more especially to the green-yellow. In this way the part of the spectrum used for photographing could be reduced to a narrow band about midway between the D and E lines in the solar spectrum. By this means he succeeded in obtaining the photographs exhibited, and which he had avoided touching up. Whether these markings were true or spurious was a question he did not touch, but they appeared to have as good a claim as those on *Surirella gemma*. He thought it more probable that in both cases they were simply multiplied rings of the midrib and sides produced by the higher order of diffraction spectra according to the Abbe theory. The mounts of *A. pellucida* used were of realgar, or rather a higher sulphide of arsenic, prepared by mixing sulphur with realgar. He found it extremely difficult to make mounts with such a large proportion of realgar. The mounts being of a deep orange colour inclining to red, enabled the coloured screen to be dispensed with. But this highly refracting medium very soon cracks off the cover-glass. The advantage of working with this form of illumination and a suitable colour-correct plate is that ordinary achromatic object-glasses perform almost as well as apochromatic. He could not see the beaded markings with any glass of less aperture than 1·4; the best results being obtained with Powell and Lealand's apochromatic $\frac{1}{10}$ of 1·5, also with their achromatics $\frac{1}{20}$ of 1·5 and $\frac{1}{12}$ of 1·43. He also used in photographing a Zeiss projection ocular.—Mr. E. M. Nelson, speaking of the value of drawings made with Beale's neutral tint reflector, said he had tested the matter by making a drawing of lines on a micrometer scale of $\frac{1}{100}$ mm. under an apochromatic objective giving a magnifying power × 850; he found on measuring that they showed only a very slight displacement.—Mr. Curties exhibited a new form of microscope made on the Nelson model.—Mr. Nelson described some improvements in his apparatus for producing pure monochromatic light for use with the microscope.—Mr. A. W. Bennett gave a *résumé* of his paper on the fresh-water Algæ of South-west Surrey, in which he describes several new species.

CAMBRIDGE.

Philosophical Society, November 9.—Dr. Gaskell in the chair.—The following communications were made:—On a *Peripatus* from Natal, by Mr. A. Sedgwick.—On variations in the colour of cocoons (*Saturnia carpini* and *Eriogaster lanestris*), with reference to recent theories of protective coloration, by Mr. W. Bateson. The cocoons of several moths, *e.g.* the emperor and small egger, vary in colour from dark brown to white. It is believed by some that these colours have a protective value as a means of concealment, and it has been stated by Poulton and others that when spun on leaves which will turn brown, or in dark surroundings, the cocoons are dark, while they are white if spun on white paper. To account for this phenomenon "the existence of a complex nervous circle" has been assumed. The present experiments showed that it is true that larvæ left to spin on their food-leaves produce dark cocoons, and also that if they are taken out and put in white paper the cocoons are white. But it was found that larvæ similarly *taken out* and made to spin in dark substances also spun white cocoons, and indeed that starvation, parasites, or interference at the time of spinning, lead to the production of a white cocoon. On the contrary, if white paper is put amongst the food, so that the larvæ can, of their own choice, walk into it and spin, the cocoons are generally dark. It was noticed in several cases that larvæ which had been shut up evacuated a quantity of dark juice having the natural tint of the cocoon, and the suggestion was hazarded that absence of colour in the cocoon perhaps results from the loss or retention of this juice, which may be of the nature of meconium.—Exhibition of *Phylloxera vastatrix*, by Mr. A. E. Shipley.—On digestion in *Ammocœtes*, by Miss R. Alcock (communicated by Dr. Gaskell).—On the reaction of certain living cells to methylene-blue, by W. B. Hardy.—The chair was taken by Prof. Hughes during the reading of the last two papers.

PARIS.

Academy of Sciences, November 30.—M. Duchartre in the chair.—The reclaiming and cultivation of land in the Camargue, by M. Chambrelent. A description of the irrigation, cultivation, procuring of potable waters, and means of transpor, introduced in the Camargue. This district is contained between two branches of the Rhone, 50 and 58 kilometres long respectively, which reach the sea at points about 40 kilometres from each other. The bifurcation occurs at Arles, about 50 kilometres from the coast. At the beginning of this century the land was absolutely unfertile, and the inhabitants were unprovided with potable water. The author states the success that has attended the efforts that have been made to remedy this state of things, and bring the land under cultivation.—Observations of the asteroid discovered by M. Borrelly, at Marseilles Observatory, on November 27, 1891, by M. Borrelly. The positions are given for November 27 and 28.—*Résumé* of solar observations made at the Royal Observatory of the Roman College, during the third quarter of 1891, by M. P. Tacchini. (See Our Astronomical Column.)—On the tides of the Bay of St. Malo, by M. Heurtault. The author has made tidal observations at St. Malo for the last eighteen years, and states some of the results. The mean monthly level of the sea appears to have a minimum value in April and a maximum in October. The mean annual level increased gradually from 1874 to 1883, and has since been diminishing. The establishment of the port also indicates similar variations. Thus it passed from 6h. 55m. in 1874 to 6h. 10·24m. in 1884, and has since exhibited a tendency to diminish. Its months of maxima are April and September, and of minima July and December, the general mean being 6h. 8·9m. Contrary to Laplace's statement—"*Plus la mer s'élève lorsqu'elle est pleine, plus elle descende en basse mer suivante*"—it has been found from observations of 45 tides, that in only 25 did the lowest sea follow the highest tide; 3 times it immediately preceded, and 17 times it occurred two tides before.—Phosphides of boron, by M. A. Besson. The preparation and properties of boron phosphide, PB, are described; the possible existence of a more stable compound is also indicated.—On the bromine derivatives of methyl chloride, by M. A. Besson. The compounds CH_2BrCl and $CHBr_2Cl$ have been prepared. The author has not yet succeeded in isolating CBr_3Cl. (1) The compound CH_2BrCl is a colourless liquid distilling without decomposition at + 68°, solidifying at − 55°; its specific gravity is 1·90. (2) $CHBr_2Cl$ boils between 117° and 119°, and solidifies at − 32°.—On a modification of the calorimetric bomb of M. Berthelot, and upon the industrial determination of the calorific power of combustibles, by M. Pierre Mahler.—On the fixation of free nitrogen by plants, by MM. Th. Schlœsing, Jun., and Em. Laurent. The conclusions drawn from the data obtained are the following:—(1) There are some inferior green plants capable of fixing gaseous nitrogen. (2) Under the conditions of experiment peas take up much atmospheric nitrogen, whereas fallow soils, oats, mustard, cress, and spurrey are not capable of fixing a measurable quantity. The paper has remarks by M. Berthelot appended.—The ammonia in the atmosphere and in the rain of a tropical region, by MM. V. Marcano and A. Muntz. The observations were made at Caracas, in the Gulf of Venezuela, lat. 10°·3 N., altitude 922 metres. An examination of twenty samples of rain gave a mean proportion of ammonia of 1·58 milligram per litre, with a minimum of 0·37 and a maximum of 4·01. The proportion of gaseous ammonia present has been determined by exposing a known surface of acidulated water to the air and observing the ammonia absorbed in a certain time. Eleven determinations, extending over 174 days, have been been made, and they show that, on the average, an acid surface of 1 mq. absorbed, in twenty-four hours, 12·52 mgr. of ammonia, with a minimum of 5·30 mgr. and a maximum of 27 mgr. It appears, therefore, that the air of the tropical station is not so rich in gaseous ammonia as that of temperate regions.—Influence of the sun's rays on the bacilli of fermentation found on the surface of grapes, by M. V. Martinand.—On some effects of the parasitism of plants, by M. A. Magnin.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, DECEMBER 10.

ROYAL SOCIETY, at 4.30.—On a Compensated Air-Thermometer: H. L. Callendar.—Note on the Necessity of using Well-annealed and Homogeneous Glass for the Mirrors of Telescopes: A. A. Common, F.R.S.—On some of the Properties of Water and of Steam: Prof. Ramsay, F.R.S., and Dr. Young.—On the Surya Siddhanta (Hindoo Astronomy): W. Brennand.—Repulsion and Rotation produced by Alternating Electric Currents: G. T. Walker.

MATHEMATICAL SOCIETY, at 8.—The Equations of Propagation of Disturbances in Gyrostatically-loaded Media: Dr. J. Larmor.—Theory of Elastic Wires: A. B. Basset, F.R.S.—Researches in the Calculus of Variations; II. Discrimination of Maxima and Minima Solutions when the Variables are connected by Algebraical Equations, the Limits being supposed Fixed: E. P. Culverwell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.—Election of Council and Officers.—On the Specification of Insulated Conductors for Electric Lighting and other Purposes: W. H. Preece, F.R.S.

LONDON INSTITUTION, at 7.—An Hour with my Mozart Manuscripts (Illustrated): Prof. Bridge.

CAMERA CLUB, at 8.—A Short Description and Demonstration of New Telescopic Lens for Photography: T. R. Dallmeyer.—The Use of the Lantern for Scientific Illustration: Dr. A. H. Fison.

FRIDAY, DECEMBER 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 7.30.—Meters for Recording the Consumption of Electrical Energy: C. H. Wordingham.

CAMERA CLUB, at 8.—Retouching Class.

SATURDAY, DECEMBER 12.

ROYAL BOTANIC SOCIETY, at 3.45.

SUNDAY, DECEMBER 13.

SUNDAY LECTURE SOCIETY, at 4.—The Origin and History of the Thames (with Oxyhydrogen Lantern Illustrations): Prof. J. F. Blake.

MONDAY, DECEMBER 14.

SOCIETY OF ARTS, at 8.—The Pigments and Vehicles of the Old Masters: A. P. Laurie.

ARISTOTELIAN SOCIETY, at 8.—The True Sense of the Term *a priori*: J. H. Muirhead.

LONDON INSTITUTION, at 5.—Tropical Plants and Flowers (Illustrated): D. Morris.

CAMERA CLUB, at 8.30.—Development: Lyonel Clark.

TUESDAY, DECEMBER 15.

ROYAL STATISTICAL SOCIETY, at 7.45.—Enumeration and Classification of Paupers and State Pensions for the Aged: Charles Booth.

UNIVERSITY COLLEGE BIOLOGICAL SOCIETY, at 5.15.—The Sources of Nitrogenous Food of Leguminous Plants: H. Thompson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sale of Water by Meter in Berlin: Henry Gill. (Discussion.)

WEDNESDAY, DECEMBER 16.

SOCIETY OF ARTS, at 8.—Typological Museums, as Exemplified by the Pitt Rivers Museum at Oxford: General Pitt Rivers.

ROYAL METEOROLOGICAL SOCIETY, at 7.—Report on the Thunderstorms of 1888 and 1889: William Marriott.—On the Prevalence of Fog in London during the Twenty Years 1871–90: Frederick J. Brodie.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Resolution of Podura: Hon. J. G. P. Vereker.

INSTITUTION OF CIVIL ENGINEERS, at 2.—Students' Visit to the Stations of the Westminster Electric Supply Corporation, 11 Millbank Street, and Eccleston Place, S.W.

CAMERA CLUB, at 8.—Retouching Class.

THURSDAY, DECEMBER 17.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—Development of the Head of the Imago of Chironomous: Prof. L. C. Miall and A. R. Hammond.—On Two Species of Cumacea in New Zealand: G. M. Thomson.

CHEMICAL SOCIETY, at 8.—The Composition of Cooked Vegetables: Miss K. Williams.—On some Metallic Hydrosulphides: S. E. Linder and H. Picton.—On the Physical Constitution of some Solutions of Insoluble Sulphides: Harold Picton.—Solution and Pseudo-solution: H. Picton and S. E. Lindor.—The Change proceeding in Acidified Solutions of Sodium Thiosulphate when the Products are retained within the System; and The Action of Sulphurous Acid on Flowers of Sulphur: Dr. A. Colefax.—The α and β modifications of Chlorobenzene Hexachloride: Dr. Matthews.—Camphrone, a Product of the Action of Dehydrating Agents on Camphor: Drs. Armstrong and Kipping.—Studies on the Dibromonaphthalenes: Dr. Armstrong and Mr. Rossiter.

LONDON INSTITUTION, at 6.—Winchester Cathedral (illustrated): Very Rev. the Dean of Winchester.

CAMERA CLUB, at 8.30.—Simplified Collographic Process (Description and Demonstration): Leon Warnerke.

FRIDAY, DECEMBER 18.

PHYSICAL SOCIETY, at 5.—On Interference with Alternating Currents: H. Kilgour.

CAMERA CLUB, at 8.—Retouching Class.

BOOKS, PAMPHLETS, AND SERIALS RECEIVED.

BOOKS.—The Universal Atlas, Part IX. (Cassell).—The Powe which Propel and Guide the Planets: S. Laidlaw (Kegan Paul).—Progressive Mathematical Exercises, First Series: A. T. Richardson (Macmillan).—The Principles of Chemistry, 2 vols.: D. Mendeléeff; translated by G. Kamensky; edited by A. J. Greenaway (Longmans).—Lehrbuch der Vergleichenden Entwicklungsgeschichte der Wirbellosen Thiere, Specieller Theil, Zweites Heft: Dr. E. Korschelt and Dr. K. Heider (Jena, Fischer).—Proceedings of the American Association, August 1890 (Salem).—Oriental Cicadidæ, Part 4: W. L. Distant (London).—Annalen der k.k. Universitäts-Sternwarte in Wien, Band vii. (Williams and Norgate).—Travels in Africa during the Years 1879–1883: Dr. W. Junker; translated by A. H. Keane (Chapman and Hall).—An Essay on Reasoning: E. T. Dixon (Cambridge, Deighton).—Proceedings of the U.S. National Museum, vol. xiii., 1890 (Washington).—An Introduction to Chemical Theory: Dr. A. Scott (Black).—Himalayan Journals: Sir J. D. Hooker (Ward, Lock).—Falling in Love, &c.: Grant Allen; new edit. (Smith, Elder).—Nature and Man in America: N. S. Shaler (Smith, Elder).—Annuaire 1891, par le Bureau des Longitudes, Paris (Gauthier-Villars).—Connaissance des Temps ou des Mouvements Célestes, 1893 (Gauthier-Villars).—Ephémérides des Etoiles de Culmination Lunaire et de Longitude pour 1891: M. M. Lœwy (Gauthier-Villars).—The Harveian Oration on Harvey in Ancient and Modern Medicine: Dr. W. H. Dickinson (Longmans).—The Cause of an Ice Age; Sir R. S. Ball (Kegan Paul).—Scientific Results of the Second Yarkand Mission—Introductory Note and Map, 1878–91.—Scientific Results of the Second Yarkand Mission—Aves: Dr. R. B. Sharpe (Taylor and Francis).—Animal Sketches: C. Lloyd Morgan (Arnold).—A Manual of Physics: Dr. W. Peddie (Baillière).—Memory, its Logical Relations and Cultivation: Dr. F. W. Edridge-Green; 2nd edition (Baillière).

PAMPHLETS.—Connaissance des Temps, Extrait pour l'an 1892 (Paris, Gauthier-Villars).—Australian Museum, Sydney; Hand-List of Australian Mammals: J. D. Ogilby (Sydney).—Compass-Deviation; Syllabus of Examination in the Laws of Deviation (Imray).

SERIALS.—Records of the Australian Museum, vol. i., No. 9 (Sydney).—North American Fauna, No. 5 (Washington).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1891, Part 2 (Philadelphia).—Brain, Parts 54 and 55 (Macmillan).

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