THURSDAY, OCTOBER 12, 1905.

TWO RECENT VOLUMES ON ARACHNIDA.

On Two Orders of Arachnida. Opiliones, especially the Suborder Cyphophthalmi, and Ricinulei, namely, the Family Cryptostemmatoidae. By Dr. H. J. Hansen and Dr. W. Sörensen. Pp. 1–182; 9 plates. (Published by aid of a subsidy from the Royal Society of London, Cambridge, 1904.) Price 15*s*. net.

Palaeozoische Arachniden. By Prof. Dr. Anton Fritsch. Pp. 1–80; 5 plates and many text figures. (Prag: Selbstverlag. in comm. bei Fr. Řivnáč, 1904.)

ARACHNOLOGISTS must unite in a vote of thanks to Drs. Hansen and Sörensen for their splendid achievement in producing their treatise on Arachnida. The volume, announced many years ago as in preparation, is based upon a wealth of material borrowed from every available source such as no other taxonomists have been able to examine. It is a monument of careful research, and in every way worthy of the high reputation of its authors. Though written in a foreign tongue, the letterpress contains no passage of doubtful meaning; and Hansen's inimitable drawings have received full justice from the lithographic skill of Wilson at Cambridge. The Royal Society was well advised in contributing to the cost of publication.

The first and most valuable part of the book deals with the Opiliones, a highly specialised order the morphology of which has baffled previous workers. By the comparative and careful study of a host of forms, the Danish authors have succeeded in explaining the complicated structure of the genital area, or at all events in offering an explanation which will probably stand unless ultimately disproved by embryology. They have accepted the opinions of Simon and Thorell as to the division of the order into three suborders, and supplied diagnoses of the families of the Palpatores. In the case of the Cyphophthalmi, the least known of the suborders, a complete monograph of all the species is given, together with some new anatomical details, including the important discovery that the so-called ocular tubercles bear, not eyes, but the orifices of Krohn's glands. Incidentally, Stecker's monster, Gibbocellum, is disposed of, and, it is safe to say, will never again figure in literature.

The second part deals with an order of peculiar interest, the Ricinulei or Podogona, which has existed unchanged from Carboniferous to modern times. Amongst the anatomical discoveries made by Hansen and Sörensen, two stand out as of the greatest interest, namely, the presence of a pair of tracheal respiratory organs in the prosoma and of the elements of nine somites in the opisthosoma. The association of this order with the Pedipalpi, Araneæ, and Palpigradi is of interest, even if the reasons for it are unconvincing; but surely greater prominence should have been given to the fact that Börner anticipated the Danish authors in this matter!

Exact and admirable, however, as the work is, it must not be regarded as above criticism; nor must all the statements be accepted with a childlike faith. Far from it. The limitations of the authors are well known and are sufficiently in evidence in this volume, more especially in the pages dealing with the Micrura. For example, Börner's view that the "labia" in Arachnida are not homologous sclerites is worth far more than the unreasoned dismissal it receives; and it is not very obvious why the first abdominal sternal plate in the Ricinulei is homologised with the pregenital rather than with the genital sternite of the Pedipalpi. Exception also must be taken to the application of the term "antenna" to the appendages of the first pair, and of "mandibles" to the basal segment of those of the second pair, in the Arachnida. The first change is defensible only on the grounds that the chelicerae of the Arachnida are the homologues of the antennæ of insects and of the antennæ of the first pair in crustaceans. Those who adopt this terminology, however, must consistently apply the term "antenna" to the buccal gnathites of Peripatus. Again, the name "mandible" is presumably given to the basal segment of the appendages of the second pair because of its supposed homological correspondence to the "mandible" of the insects or crustaceans—an opinion not generally accepted.

Points of this kind, however, would scarcely be worth mentioning were it not for the apparent inclination on the part of the authors to forget the possibility of two or more views being held on matters about which embryology is, up to the present, silent. As a last word of praise, may we, in all sincerity, congratulate the authors on the considerate tone of their criticisms and on the general absence of that air of self-satisfied arrogance for which certain Danish publications on Arthropoda have gained an unenviable notoriety? It is to be hoped that the English supervision of the letterpress is not in any way responsible for this improvement.

Dr. Fritsch's monograph of the Palæozoic Arachnida is a volume of a quite different character. Plainly speaking, it is an anachronism reminiscent of the dark days of palæontology when that science was held to be independent of neontology, or at all events independent in the sense that an acquaintance with the structure of the living species of a group was regarded as superfluous for the correct determination and description of its fossil forms. The comparative morphology of recent Arachnida, even with well-preserved material for examination, is difficult enough. Was it likely, then, that any great measure of success would attend the efforts to interpret the elusive structural points of Carboniferous fossils of a palæontologist unguided by scientific familiarity with recent forms? But, although want of the requisite knowledge is plainly attested and shatters all confidence in the alleged observations and attempted restorations, yet without examination of the specimens themselves no one has the right to affirm positively that a statement is false or a drawing inaccurate in any given particular. However strongly one may suspect the contrary, there *may* have been a scorpion in Carboniferous times with the appendages segmented as shown in the figure of *Isobuthus kralupensis* (p. 71); or another with an additional sternal plate between the normal second and third of the opisthosoma, as in the restoration of *Microlabis sternbergi* (p. 69). Most of the specimens are in continental museums; but it so happens that there is in the British Museum a fossil scorpion which Fritsch figures and describes in the present work as *Eobuthus rakovnicensis*. To one acquainted with recent scorpions, it is obvious that this fossil resembles them in all essential points. Yet Fritsch's restoration represents an animal differing from all known forms in characters falling so wide of one's experience that it is impossible to estimate their systematic value. If this be taken as a test case, it supplies convincing proof of the untrustworthiness of the drawings and diagnoses in the book; for it shows that the author's anatomical knowledge is too superficial to enable him to distinguish between fortuitous fractures and inter-segmental joints in the fossil examples.

Haase's classification of the Carboniferous Arachnida is followed tolerably closely. To the Araneæ (spiders), however, is added the new suborder Pleuraraneæ; but its genera seem to be nothing but Anthracomarti. Promygale, for instance, differs from Anthracomartus only in the alleged presence of abdominal appendages. The evidence, however, for the existence of these seems to be of the slenderest kind. In the Opiliones figures the new genus Dinopilio, which presumably should be classified under the Araneæ, perhaps near the Arthrolycosidæ.

The volume nevertheless contains some valuable work, in addition to its usefulness as a catalogue and bibliographical record. The discovery that in the Carboniferous scorpions the lateral eyes are in advance of the medians, as in recent species, disposes of Thorell's classification of these animals into Anthracoscorpii and Neoscorpii. The author is also to be congratulated upon showing that the structure from which Cyclophthalmus took its name is a half-circle, not of ocelli, but of granules.

It is impossible not to regret the necessity for giving an unfavourable notice of a volume which has cost its author much time and trouble; but since his high reputation as a palæontologist and the style of the illustrations are likely to deceive the uninitiated into regarding this treatise as an epoch-making monograph, it would be unfair to do otherwise than utter a note of warning against putting reliance in its contents to those not in a position to judge of its merits for themselves.

R. I. POCOCK.

THE CITIZEN AND THE STATE.

The Citizen, a Study of the Individual and the Government. By Nathaniel Southgate Shaler. Pp. viii+339. (London: A. Constable and Co., Ltd., 1905.) Price 5s. net.

PROF. SHALER, who is professor of geology at Harvard, has set before himself the practical and unambitious task of instructing the youth of the United States in the first principles of citizenship. In this he has succeeded; his work is interesting, suggestive, and extremely sensible. Not being written for the specialist, it is hardly to be called profound; and the theoretical considerations which are brought forward are of the simplest. But the author's sound common sense generally carries the reader with it. A favourable specimen of his mode of argument may be found in the discussion of woman's suffrage. There is no reference to the various views held by thinkers from Plato downwards; but probably Prof. Shaler's one-page argument is quite sufficient, that women, owing to their usually secluded lives, are not fitted in the same way as men to form judgments on political questions, but that, after all, if a majority of women should desire to vote, it would probably be best to give them the franchise, for the reason that it is most undesirable to have any considerable body of the people in a discontented state.

Only a few of the topics discussed in this book can be referred to here. Prof. Shaler takes the moderate view that it is more profitable to the commonwealth to engage the interest of a hundred thousand well-informed men in politics than to have a hundred able statesmen created for public affairs. He depreciates the importance of oratory for the statesman in the present condition of American society, regards a sound head for business and a faculty for clear statement as much more valuable, and contends that the most successful statesmen in America are not (as in England) gentlemen of independent means, but lawyers and business men, whose training has taught them how to enter into associations with other men, to limit themselves to practical aims, and to form the schemes necessary for their realisation.

Naturally, in a work proceeding from the United States, one looks for, and finds, the glorification of the ideals and great men of that country; the contrast drawn between Washington and Napoleon; the contention that the War of Independence broke out because the American colonists had outgrown the system of the mother country; the distinction, too, which is drawn between the soldier and the citizen spirit. Prof. Shaler sees clearly, and discusses with impartiality, some of the most pressing difficulties of American politics. Not much is said about trusts and tariffs, and the currency is dealt with briefly. But immigration, foreign possessions, and the negro question are quite adequately treated. Prof. Shaler laments, of course, that the streams of immigrants no longer come from the most healthy strata of society in Europe; and, in addition to criminals, paupers, and other defective persons, he would exclude those who are not able to read and write in the English language or their own. He gives no support to the view that the mere profession of the doctrines of Anarchism should be followed by condign punishment. He sees no necessity for any attempt to extend the possessions of the United States beyond the sea. "Lynch law" he holds in detestation, and calls upon young America, on the occasions of any outbursts, however natural, of the lawless desire for vengeance, to put itself under the orders of the sheriff and even to fire on the riotous crowd. As for the negroes, whom the United States have always with them, he suggests only the need for training in the simpler arts and handicrafts; for a literary education, in his judgment, they are still wholly unfit.

PRACTICAL ORGANIC CHEMISTRY.

A Systematic Course of Practical Organic Chemistry. By Lionel Guy Radcliffe, with the assistance of Frank Sturdy Sinnatt. Pp. xi+264. (London: Longmans, Green and Co., 1905.) Price 4*s.* 6*d.*

THIS book is intended mainly for students of elementary organic chemistry. The students are supposed to work about five hours per week, and, consequently, experiments which take a longer time, and must be finished without interruption, are omitted.

The exercises include a variety of important reactions and involve work with many of the more common compounds and reagents in organic chemistry. There is a set of exercises on the fatty compounds, and another on benzene; these include instructions in the observation of melting point and boiling point, in the determination of specific gravity, of the equivalent of an acid, and of sugar by the use of Fehling's solution.

This course worked through, there is a higher course, including the preparation of such substances as anisol, benzyl chloride, and benzaldehyde, the determination of equivalents and molecular weights, and of carbon, hydrogen, nitrogen, &c.

More care might have been spent on the finish of the book. The punctuation has been neglected; *e.g.* "recrystallise until the m.p.'s do not change" (p. 16), and "recrystallise the hydrobenzamide, formed from hot alcohol" (p. 110). The diction is not what it ought to be. "Heated alone succinic acid *sublimates*" (p. 196). "See if the *example* obtained [of methyl orange] is sensitive to acids" (p. 96).

The instructions for experiments are fairly detailed and generally good. Certain mistakes have been made. The student is repeatedly directed, after having dried a preparation by calcium chloride, to distil it in presence of the drying agent (*e.g.* pp. 54, 176). If a dry distillate is desired, the distillation should be carried out after removing the calcium chloride. Again, in determining molecular weight by Victor Meyer's method, the volume and temperature of the expelled gas may surely be read without waiting so long as an hour (p. 120). Is a minute not long enough?

Under protest, the authors give a section on the qualitative analysis of organic mixtures, "for the sake of students who are taking certain examinations." "The authors are quite sensible of the fact that the analysis of such mixtures cannot be regarded as useful practical organic chemistry" (p. 172). Surely this is an impatient verdict. Qualitative analysis is a valuable training in so far as the student is led to bring book knowledge to bear on work in the laboratory, and is prevented from taking suspicion for proof. The teacher should require him, in every case, to produce a specimen (or a derivative) of each constituent of the mixture. With this stipulation, knowledge, resource and judgment are needed in organic qualitative analysis even more than in inorganic. How many different ways are available for the separation of organic substances from one another:—precipitation, the use of different solvents, ordinary and steam distillation, extraction by ether from acid and alkaline solution, hydrolysis, oxidation, &c.! Surely time spent in mastering these methods of analysis is not wasted. A. N. M.

OUR BOOK SHELF.

Die Entwickelung der electrischen Messungen. By Dr. O. Frölich. Pp. xii+192; 124 illustrations. (Brunswick: Vieweg and Son, 1905.) Price 6 marks.

THIS is the fifth of a series of scientific monographs published under the general heading *Die Wissenschaft.* It consists of an historical sketch of the development of physical measurements, especially of those connected with electrotechnics. It must be admitted that in this go-ahead age the technical man finds little time to make a retrospect of his subject; he is too much concerned with its developed aspect. Even in colleges and schools, as the publisher states, the historical side of the subject is too much neglected. The present volume is intended to remove this reproach.

To give an idea of the book, we will outline here the first chapter (on current measurement). In its first section it deals with the first galvanometer, starting with the work of Oersted and Schweigger on the action of a current on a magnetic needle. Then follow the fundamental laws of constant currents as developed by Ohm, Ampère, Biot-Savart, and the methods of demonstrating them. The astatic needles of Nobili and Davy and the measurements of Faraday are next described, and this section concludes with the methods devised for calibrating the early types of galvanometer.

The second section is called the mirror galvanometer. It describes the work of Gauss and Weber on absolute measurements, the first telegraph of Gauss and Weber (1833), and the Atlantic cable furnished with mirror galvanometers by Lord Kelvin (1858). The remainder of the section deals with improvements effected in the control of the moving system (damping, &c.), and describes the galvanometers of Wiedemann, Siemens, and Kelvin, and the more recent variants of du Bois and Rubens, Paschen, Hartman and Braun, d'Arsonval, Edelmann, and Siemens and Halske.

When it is mentioned that all this is included in thirty pages it will be realised that the descriptions are exceedingly brief. The general impression conveyed is that for a book of this kind to be of much use, fuller treatment is necessary. Still, it will serve to direct attention to the general trend of advance, and to indicate the names of those that share the chief honour of it. Its value would be considerably increased by a larger number of references to original sources of information. These are given sometimes only.

Zoologischer Jahresbericht für 1904. Edited by Prof. P. Mayer. (Berlin: Friedländer and Son, 1905.)

THE zoological station at Naples, for which this bulky volume, like its predecessors, is published, is to be congratulated on the early date of its issue and the thoroughness with which the various contributors have done their work. In issuing a register of zoological work for 1904 so early as September of the present year, the editor and publisher have indeed beaten our own "Zoological Record"; but it must be remembered that in the present volume is included a considerable amount of literature belonging to earlier years, while it is difficult to believe that the whole of the papers for 1904 can be included.

It might be imagined, for those not conversant with the two works, that the "Zoologischer Jahresbericht" is a serious rival to the "Zoological Record," and that the publication of the one renders that of the other superfluous. As a matter of fact, this is not the case; for, in the first place, it is highly desirable that a record of zoological literature should be published in English, and, in the second, the two publications do not cover the same ground. The "Zoological Record," for instance, is specially devoted to the systematic aspect of the subject, particular pains being taken to include the names of all new species and subspecies. In the Continental work, on the other hand, systematic work is rigorously excluded, and attention concentrated on the bionomical, anatomical, and physiological aspects of the subject. The two records are therefore to a considerable extent supplemental and complementary to one another, more especially as in the one before us a somewhat full *précis* of the main subjects of the more important papers forms an important feature. The practice of including all the papers on Vertebrata under a single heading does not, indeed, appeal to us; but then, it is true, this is in some degree compensated by dividing the summary of their contents into their respective class-positions. So far as we have been able to judge, the quotations of the titles of the papers and the references to their places of publication are singularly free from error, and the volume, like its predecessors, cannot fail to be of the highest value to all workers in morphological and anatomical zoology.

R. L.

Examples in Arithmetic. By C. O. Tuckey. Pp. xii+241+xxxix. (London: George Bell and Sons, 1905.) Price 3*s.*

The Primary Arithmetic. Parts i. and ii. Edited by Dr. Wm. Briggs. Pp. 80 and 94. (London: The University Tutorial Press.) Price 6*d.* each.

THESE books are intended for the use of teachers who instruct their classes orally in the processes and rules of arithmetic, and who only require the assistance of graduated sets of exercises. In the work by Mr. Tuckey the course is fairly complete, embracing the usual commercial arithmetic, with a chapter on the application of proportion to problems in geometry and physics, and a section devoted to numerical computations by the aid of compound interest, logarithmic and trigonometrical tables, in which a little elementary trigonometry is introduced. There are examples on graphs and squared paper work, and the users of the book will have an abundant choice of exercises of modern type.

"The Primary Arithmetic" will be complete in three parts. The first part gives sets of exercises on the four simple rules and on the compound rules for money. The examples increase in difficulty by almost imperceptible stages, beginning with those of the simplest kind, and they are suitable for very young scholars. Part ii. completes the compound rules for weights and measures, including the metric system. Then follow exercises on vulgar fractions and on practice and invoices. In these two parts, as well as in the book by Mr. Tuckey, the answers to the exercises occupy a considerable space at the end of each volume.

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.*]

A Magnetic Survey of Japan.

IN NATURE of April 20 (vol. lxxi. p. 578), Prof. A. Schuster has given a comprehensive review of the magnetic survey of Japan with a friendly criticism. The responsibility of its writer may be a sufficient excuse for the following remarks partly in way of reply.

Prof. Schuster directs attention to the small space given to the description of the working of the instruments. This arises from the fact that these instruments were essentially the same as the one used in the previous survey of 1887, and described in vol. ii., pp. 178–193, of the *Journal of the College of Science,* Imperial University, Tokyo, to which the reader is referred for details. A few improvements that have since been made are mentioned in the present report, pp. 7–8.

We are glad to see that the methods adopted for calculating the corrections for heights of stations and the way of disposing with the vertical current met his approval; only Prof. Schuster seems to attribute these currents to uncertainties in the observations, whereas we infer that they are as much, if not more, due to the inadequacy of the empirical formulæ, from the fact that they vanish near the middle of the several countries treated (p. 125).

Perhaps the more important point is with regard to the question of the seat of action. To avoid confusion, it might be well to remark that the word potential is used in different senses by different writers; some use it to denote a function which satisfies the Laplacian equation $\nabla^2 V=0$, and others to denote the line integral of any irrotationally distributed vector, whether the solenoidal condition be satisfied or not. It is in the latter general sense that the word is used in the report.

Now Gauss's method of separating internal and external sources of action is based upon the assumption that these sources are entirely separated from each other by a free space; in other words, the Laplacian equation holds strictly over a finite portion of the space surrounding the earth surface. This is very plausible when we consider the earth as a magnetised body, as appears *a posteriori.* But when we abandon the restriction of the solenoidal distribution the method is no more applicable, and the observation of force over a spherical surface is not sufficient to settle the seat of action, although it may be expansible in harmonic form if its distribution is continuous, so that the Gaussian expansion must be taken in "Gauss's sense" (end of first paragraph, p. 140 of the report).

The possibility of the distribution of magnetism in the space surrounding the earth surface might appear quite extravagant, and may be included amongst what Gauss calls "boldenlose Phantasien," so long as we are considering the main causes of the terrestrial magnetism; but when we come to discuss the external causes and the horizontal atmospheric current the effects of which amount to only a small fraction of the observed forces, our assumption of the distribution being thoroughly solenoidal would seem subject to doubt, or at least to require observational evidence, so that "strictly speaking, the mode of distribution must remain perfectly arbitrary so long as we adhere solely to the observed elements" of magnetic forces on a spherical surface, when no further assumption than the Newtonian law of action is admitted.

It may not be unnecessary to add here that the search for the seat of action from observations of force over a surface is an inverse problem, and includes any arbitrary distribution of magnetism the resultant effect of which vanishes on that particular surface; we can put any system of magnets or electric circuits outside the surface, provided we envelop that surface with a counteracting shell or shells over which a proper distribution of magnetism is made according to Green's method of finding the density of induced electricity on a conductor, besides any amount of closed magnetic shells and solenoids. It will thus be seen that even if we take the internal and external sources to be detached, the plain proposition given by Prof. Schuster would appear to require a modifying clause in order to be exact. A. TANAKADATE.

Physical Laboratory, Imperial University, Tokyo, August.

A Polarisation Pattern.

THE following may be of interest to some of your readers. A cylindrical mica chimney of an Auer gas-light is placed vertically on a varnished table. If we look through it at the diffused daylight from a window reflected by the table, faint coloured bands are seen running parallel to the length of the cylinder near both edges. If observed through a Nicol's prism, the band appears very beautiful.

T. TERADA.

Physical Laboratory, Science College, Imperial University, Tokyo, September 8.

A Focusing Screen for Use in Photographing Ultra-violet Spectra.

THE sensitive surface upon which Stokes projected the ultra-violet rays when observing metallic lines and absorption spectra consisted of a plate of plaster of Paris moistened with a paste of uranium phosphate acidified with phosphoric acid (*Journ. Chem. Soc.*, vol. xvii., 1864). Soret used uranium glass and solutions of fluorescent substances such as æsculine in liquid cells. I have found that the most convenient and effective screen for examining spectra with a quartz spectrograph is one such as is used for the X-rays. It may be made as follows:—a photographic plate is first cleared of silver bromide by fixing and washing, and when the film is partly dry, but the gelatin still soft, it is dusted over with a powder of barium platinocyanide crystals, so as to be somewhat thickly coated with the salt. This is fixed in the dark slide of the camera. To focus a spectrum, the slide is tilted to the necessary angle, and a somewhat powerful focusing glass with a flat field is applied to the uncoated surface of the plate, when both the visible and ultra-violet spark spectra may be plainly seen by transmission, the latter by reason of the fluorescence excited. The focusing glass should be first carefully adjusted for any visible object on the other side of a plain glass plate, such as a fine hair fastened upon it, and the position of the eye-piece is then fixed. Suitable focusing glasses are those made by Dallmeyer and by Taylor, Taylor, and Hobson. When the spectrograph has been adjusted by means of the screen, the ultra-violet lines appear quite as sharp as those in the red and yellow, even the details in the group of cadmium lines between wave-lengths 2100 and 2400 are well defined, and a very fair photograph may be obtained; but for the most accurate focusing photography must be resorted to. W. N. HARTLEY.

Royal College of Science, Dublin, October 2.

The Omission of Titles of Addresses on Scientific Subjects.

THE published reports of the British Association make an omission of an equal and opposite character to that about which your correspondent complains. Perhaps these are intended to cancel out. I refer to the publication of titles only, without any text. On receiving the last report (1904, Cambridge) I analysed this matter so far as it relates to Sections A and G, in which I am most interested. In Section A there were 83 communications, 29 of which appear by title only, and of these publication elsewhere is referred to in foot-notes in 4 cases, leaving 25 to the recollection of the audiences who heard them. Section G was better. There were 25 communications, and 13 appeared by title only; but of these 9 may be traced by those who take the trouble to consult the other publications referred to in the foot-notes. A. P. TROTTER.

Westminster, October 3.

THE INTERNATIONAL CONGRESS ON TUBERCULOSIS.

THE International Congress on Tuberculosis, held in Paris on October 2–7, has undoubtedly served as a medium for a most fruitful interchange of views by those interested in the struggle against tuberculosis. The congress was held in the Grand Palais, which from its extent enabled the members to be collected under one roof. The first day was devoted to the formal opening, when the delegates were welcomed by the President of the French Republic, who also after the close of the congress gave a reception at the Palais de l'Elysée. The chief social functions, which were characterised by complete success, comprised a reception at the Hôtel de Ville by the Municipality of Paris, an "at home" by the *Figaro*, at which performances were given by well known artistes, a soirée at the Hôtel Continental given by the president of the congress, Dr. Hérard, another at the Châtelet Theatre by the *Matin*, and a visit to Vaux de Cernay on the invitation of Dr. Henry de Rothschild.

The British Government was represented by Dr. Theodore Williams and Dr. Bulstrode, the National Association for the Prevention of Consumption by Sir William Broadbent and Dr. Perkins, while the foreign Governments and all the leading medical societies and institutions had their special official representatives.

The chief feature of the congress was reserved for the closing *séance*, when Prof. v. Behring announced that he had every reason to hope he had discovered a method of treating tuberculosis which would be as efficacious as the anti-toxin treatment of diphtheria he had first proposed in 1890.

His statement, received with great enthusiasm, was to the effect that, although he had made a great step, the value of his proposed procedure must be tested on animals in other laboratories than his own, and clinically by physicians with an intimate knowledge of the varieties of pulmonary tuberculosis, before it could be said that an actual curative medium had been found.

Prof. Behring, as had been anticipated, gave no exact details as to the method of obtaining or administering his latest therapeutic discovery, but the earlier stages of his work are to be explained in a forthcoming book entitled "Modern Problems of Phthisiogenetic and Phthisiotherapeutic Physiology illuminated by History."

His experiments have led him definitely to abandon the idea of introducing living tubercle bacilli into the human body with a therapeutic object. He has discovered a substance, to which he has given the name T.C., which represents the vital principles of the tubercle bacillus of Koch. To the presence of this substance, which possesses extraordinary fermentative and catalytic properties, is due both the hypersensibility of living organisms to Koch's tuberculin and the protective reaction against tuberculosis. This T.C. impregnates and becomes an integral part of the cells of any organism with which it comes in contact, undergoing a metamorphosis into another substance to which the name T.X. has been given.

This elaboration of T.C. in the organism is a long and perilous process. Prof. v. Behring claims to have succeeded in producing this change *in vitro* by freeing the T.C. from certain substances which impair its therapeutic action. Of these he distinguishes three groups:—(1) a substance (T.V.) only soluble in pure water, and possessing a fermentative and catalytic action. To the presence of this substance are due the toxic effects of Koch's tuberculin. One gram of this in the dry state is more toxic than a litre of the old tuberculin. (2) A globulin (T.G.L.), soluble in neutral saline solutions, and also toxic. (3) Several non-toxic substances soluble only in ether, chloroform, and the like. The residue of the tubercle bacillus after the removal of the foregoing he terms the restbacillus; this still retains the form and staining reactions of the original tubercle bacillus. The restbacillus can be converted into an amorphous substance readily taken up by the lymphatic cells of animals undergoing a metamorphosis and leading coincidently to the production of oxyphil granules in these cells and of immunity to the tubercle bacillus in the organism as a whole.

Prof. v. Behring has convinced himself that this T.C. can be elaborated *in vitro* in a fashion which will enable it to be applied efficaciously and without danger in human therapeutics, but until this has been confirmed he does not propose to publish his full results.

The scientific interest of the congress naturally divided itself into two parts, the exhibition of pathological specimens, of models, photographs, and plans of sanatoria, instruments, sterilising machinery, and the like in the museum on the ground floor of the Grand Palais, and the actual communications made to the congress. Both presented features of great importance. Among the exhibits of more especial interest were a series of specimens indicating the results of inoculation of bovine, human, and avian tubercle in different animals, lent by the Gesundheitsamt of Berlin, and a similar series shown and thoroughly demonstrated by Dr. Lydia Rabinowitsch. The latter observer had been able to show the varying grades of virulence of the tubercle bacilli from different sources, but had not been able by transference through different animals to convert bacilli with the cultural properties of bovine bacilli into those with the cultural characters of human tubercle bacilli and *vice versâ,* although this could not be seen from the naked-eye appearance of many of the specimens. Neither had she so far repeated Nocard's results of converting avian into human or human into avian bacilli, although she exhibited an example of a bird which had suffered, apparently spontaneously, from tuberculosis, in which the cultural appearances were those of human bacilli. Dr. Calmette, of the Pasteur Institute of Lille, showed an important series of specimens from goats and kids. Kids which had been fed on the milk from mothers the mammæ of which were infected with bovine tubercle presented caseation of the mesenteric glands and also pulmonary lesions, apparently spreading through the peribronchial glands and lymphatic chain, although the retropharyngeal chain of glands remained uninfected. In cases in which the mothers had been inoculated with human or avian tuberculosis or with the Timothy bacillus only the mesenteric glands were infected. Adult goats to which doses of a culture of bovine tubercle had been administered through an œsophageal tube always died rapidly of *pulmonary tuberculosis* without apparent intestinal lesions and only a few scattered points of caseation in the mesenteric glands. Nothing approaching the degree of mesenteric affection seen in kids was found. This confirms Prof. v. Behring's announcement in 1903 that pulmonary tuberculosis might result from intestinal infection without producing local lesions at the point of entry. The Alfort Veterinary College showed a series of specimens, and others were to be seen in the museum of the college, which members of the congress were invited to visit. Amongst others were examples of the comparatively rare tuberculosis of the horse, and evidences that dogs suffer severely both from pulmonary and intestinal tuberculosis. Prof. G. Petit, of Alfort, has shown that such affections are steadily on the increase, and constitute an important factor in the campaign against tuberculosis, since a household otherwise protected to the best of human ability may become infected by a pet dog, which, having acquired tuberculosis in the streets or elsewhere, subsequently lies on the bed of children and licks their faces. The tuberculosis of dogs is more often open than had been anticipated; this means that tubercle bacilli would be constantly about their mouths, and so be readily transferred. The most common organism is the human bacillus, and the dogs most affected are those from small cafés where the air is constantly full of dust and dried sputum.

In the hygienic section were full size models showing the ordinary hotel room with its heavy hangings and dust accumulation, and the same room as it should, and could at less cost, be properly furnished with easily disinfected materials. Another group showed the great superiority in light, air, and general hygiene of a prison cell over the attic rooms with skylights, often not opening, in which most servants in Paris are accustomed to sleep.

For the purpose of receiving communications the congress was divided into four sections, the first two dealing with medical and surgical pathology and therapeutics respectively, the third with the protection of infant life, and the fourth with the protection of the adult and social hygiene.

In many subjects the two former sections overlapped, especially in dealing with the nature and varieties of tuberculosis and the value of serotherapeutics. The general conclusions appeared to be that the morphological appearances of the different varieties of the tubercle bacillus and other acid-fast bacilli were very similar, but that cultural differences existed, and that there were wide variations in toxicity. Special reports were made on this subject by Profs. Arloing, Kossel, and Ravenel. These showed that the infection of man by bovine tubercle bacilli, which are the most virulent, could occur through feeding with the unsterilised milk of tuberculous cows. All mammals appeared to suffer from infection by both types of bacilli, but no other type of mammalian bacilli could be established from cultural or morphological characters. So far as was known, tubercle bacilli modified in virulence by passing through animals other than mammals could be ultimately traced to a human or bovine origin, and restored by passage through cultures and other animals to their original forms. While the general impression seemed to be that the tubercle bacillus is in reality but one species, it was admitted that no evidence of transformation of the one type into the other, in cultural characters at any rate, had so far been produced, although varying grades of virulence in each type were recognised.

In a general study of acid-fast bacilli, Drs. Besançon and Philibert distinguish between true acid-fast bacilli which remain so under all conditions of culture, growth, and passage through animals, and those which for a single generation have acquired acid-fast characters.

They found that many bacilli grown on appropriate media containing fats, of which lanoline was the best, acquire the power for some time of resisting decolorisation by acids or by acids and alcohol. Subcultures grown on similar fatty media are also acid-fast, but subcultures on ordinary media possess no such power. To distinguish between these groups it was necessary to stain for a longer period than usual, and then to expose the films to the action of acid for many hours.

When deeply stained the tubercle bacillus will resist decolorisation for twelve to eighteen hours; the pseudo-acid-fast bacilli resist for much shorter periods.

During the discussions on serotherapy it was stated that good results had been obtained by treatment with filtered broth cultures of tubercle bacilli as employed by Prof. Denis, of Louvain, with a new variety of tuberculin extracted from tubercle bacilli by means of a 1 per cent. solution of orthophosphoric acid introduced by Dr. Beraneck, of Neuchatel, and with the anti-toxic serum invented by Dr. Marmorek. The latter observer had made a medium of leuco-toxic serum, obtained by injecting goats with leucocytes of other animals, and spleen bouillon, and inoculated this from the very edge of young cultures of tubercle bacilli. These showed a rapid growth, and the products of their growth in this medium were injected into horses in repeated small doses; when these horses had been sufficiently immunised their blood was used as a source for the serum. This serum had given its best results in cases of surgical tuberculosis, *i.e.* diseases of joints and the like, but the effects in pulmonary tuberculosis were held to be such as to justify a more extended trial being given to this method.

In the subsection on therapeutics various methods of treatment were put forward, amongst others the intravenous injection of iodoform in suspension in a mixture of ether and liquid paraffin which had been tried with some success by Dr. Dewar, of Dunblane.

Several communications were made on the respiratory changes in the subjects of pulmonary tuberculosis, the general conclusion being that they in no wise differed from those in normal or slightly febrile individuals. A series of reports was made on the early diagnosis of pulmonary tuberculosis by radiography, cytoscopy, blood counts, and other methods. Dr. Theodore Williams pointed out that the time had not yet come for supplanting the ordinary methods of auscultation and percussion, an opinion strongly agreed to by Prof. Grancher and Dr. Turban, of Davos.

In the third section abundant evidence was given of the necessity of proper care being taken of children, especially to avoid infection, great stress being laid on the danger of their occupying the same room as a subject of pulmonary tuberculosis, and the absolute necessity for a properly supervised milk supply. In a general resolution of the congress it was decided to recommend the periodical Government inspection of all dairies, and that no public institution should make use of milk that had not either come from cows which had passed the tuberculin test or had been Pasteurised or boiled.

In the fourth section Dr. Newsholme directed attention to the diminution in the death rate from pulmonary tuberculosis which had followed the replacement of domestic by institutional relief.

A discussion on the relative merits of sanatorium and dispensary treatment resulted in the conclusion that each had its place, and that the educational factor must not be forgotten, since the diminution of tuberculosis depended more on prophylaxis than on individual treatment. The advantages of the French dispensaries over the out-patient departments of most English hospitals were that since one or more of these are situated in each district of Paris and other cities, patients have not far to come, and domiciliary visits could be made to encourage the carrying out of any precautions recommended. Owing to the distance from which patients come this was at present quite impossible to organise for London hospitals. Such a system had, however, been organised in connection with the dispensary attached to the Victoria Hospital in Edinburgh, and had been productive of most excellent results. It was in matters connected with hygiene and social factors generally that the most good resulted from the London congress, and it is to be hoped still more will follow the narration of the experience gained since that time. The real hope for the community as a whole would appear to lie in the protection of the individual, and more especially of the child, if Prof. Behring's views on latency and intestinal infection hold good, from infection rather than in the treatment of those already tuberculous, since even if treatment restore the latter to some degree of working capacity, and the average sanatorium result is put at five to seven years' prolongation of active life, they but serve as foci for fresh infection.

In addition to the actual scientific papers brought forward, perhaps the greatest and best work of the congress consisted in the private interchange of views between workers of different nationalities, and in the visits to various institutions, sanatoria, and hospitals in and around Paris.

The Pasteur Institute, the veterinary college at Alfort, the Boucicaut Hospital and the sanatoria at Bligny, Angicourt, and Ormesson were among those inspected by the greatest numbers.

At the concluding *séance* it was announced that the next congress would be held in America in three years' time.

THE BRITISH ASSOCIATION IN SOUTH AFRICA.

THE association party left Maritzburg early on Saturday morning, August 26, and proceeded through the upland districts to Colenso, where a halt of special interest had been arranged. Arriving at that now historic centre with some hours of daylight to spare, a visit was paid to the site of several battles and engagements connected with the attempts to relieve Ladysmith.

The next morning, August 27, the trains slowly steamed through one of the passes leading into Ladysmith, where evidence of the severity of the struggle of a few years ago was seen on every side in groups of graves and monuments. Ladysmith was left in the evening, and Majuba and Laing's Nek, with the scenes of struggles in the late war in northern Natal, were passed in the darkness. Daylight revealed Standerton in the Transvaal at hand, and Johannesburg was reached amid exclamations of wonder at the gigantic heaps of tailings from the gold workings which were passed during the last few miles of the journey.

Of the work done in Johannesburg in connection with the sections little need be said here, but the attendances were certainly remarkably good, and the discussions revealed a high average of capacity to discuss the various problems which were presented by the papers read. Prof. Darwin's own words at the close were felt to be fully deserved when he observed, in bringing the formal work to a close, that the meeting of the association in Cape Town and Johannesburg constituted one of the most remarkable and one of the most successful of the long series held in various centres in Great Britain, Ireland, and the colonies.

The more social functions connected with the visit to Johannesburg must be described as brilliant successes. These commenced with a reception by the mayor and town council at a conversazione held at the Wanderers' Club. His Excellency the High Commissioner, Lord Selborne, was present, and graciously received many of the more distinguished of the visitors and those who had been most prominent in preparing for the visit of the association in the different South African centres.

On the following days visits were paid to various mines, both to the underground and surface workings, and to the native and Chinese compounds; and courteous guides explained the various gold extraction processes. At one of the mines some thousands of natives delighted the visitors with a Kafir dance to the accompaniment of music on native pianos and drums.

A lecture by Prof. Ayrton on "The Distribution of Power," which had involved some weeks of preparation of elaborate machinery, was greatly appreciated, though many heard with wonder of his disparagement of the Victoria Falls as possible sources of power in the future.

A garden party at Sunnyside to which an invitation was given by Lord Selborne was very largely attended. Perhaps the great event of the Johannesburg visit was the occasion of Prof. Darwin's presidential address, which consisted of a *résumé* of the main features of the Cape Town section and the delivery of the second half of his official paper.

Opportunity was taken by Lord Selborne and Mr. George Goch, the Mayor of Johannesburg, to tender official welcomes to the association, to which the president replied in one of the graceful and fitting addresses which have constituted so noteworthy a feature of the visit.

Thursday, August 31, was taken up with a visit to Pretoria as the main attraction, with the addition of visits to the Modderfontein Dynamite Factory and the Premier Diamond Mine.

At Pretoria the whole party was entertained at luncheon at some of the principal hotels, and in the afternoon Sir Arthur Lawley, Lieutenant-Governor of the Transvaal, held a reception at the museum. The president and some of the visitors stayed overnight in Pretoria, where Mr. A. E. Shipley gave a lecture on "Fly-borne Diseases." The same evening Prof. J. O. Arnold lectured in Johannesburg on "Steel as an Igneous Rock."

During the concluding day of the Johannesburg visit, the general committee meeting and the annual meeting of members were held, when Dr. Ray Lankester was elected president of the association for the ensuing year, and the officers and council were re-elected with slight changes only in the *personnel* of the latter.

As many of the papers read at the various sections had proved of deep South African interest, it was heard with pleasure that local arrangements were being made to publish the same in a separate volume subject to the consent of the authors being obtained.

From Johannesburg and Pretoria several treks of special interest to geologists and others were arranged, and among these were journeys across country to Mafeking, which necessitated omitting the visits to Bloemfontein and Kimberley, but evidently resulted in compensation of quite another kind to those who braved the inconveniences and hardships of the journey.

Prior to leaving Johannesburg Prof. Darwin announced that some of his fellow-members desired to establish a permanent link between the association and South Africa, and it had been proposed that a subscription should be raised for a medal to be given annually to a South African student in commemoration of the visit of the British Association.

The journey to Bloemfontein did not afford much opportunity of seeing the country until early morning, when several scenes of war interest were passed. The arrival in Bloemfontein on Saturday, September 2, was followed by a public welcome by the mayor and town councillors and the local Philosophical Society in the Town Hall. The function was numerously attended, and the addresses were given and received with equal cordiality. During the morning the various public buildings were visited, and in the afternoon a reception and garden party were held.

In the absence through illness of Sir H. J. Goold-Adams, the Lieutenant-Governor, his place was taken by the Acting Chief Justice, Mr. Justice Fawkes, and Mrs. Fawkes, who graciously received the visitors. The trees and bush of the grounds afforded welcome shade, and all the accessories of the occasion were such as conduced to the comfort and pleasure of all present. In the evening Mr. A. R. Hinks lectured on "The Milky Way and the Clouds of Magellan."

On September 3 a visit was paid by train to the Government Experimental Farm at Tweespruit, a halt being made *en route* at Sannah's Post with its lamentable memories. In the course of the day a trek party left for Kimberley by way of Abraham's Kraal and Paardeberg, the scene of General Cronje's capture.

On the morning of Monday, September 4, the main party left by train and proceeded by Nowal's Pont, Naauwpoort and De Aar to Kimberley, which was reached early the next morning. The programme of entertainments for the next two days was very full. Naturally the diamond mines were the centres of greatest interest, and ample provision had been made for visits underground, to the pulsator, compounds, and surface works generally. Parties were made up of numbers sufficiently limited to admit of adequate explanation of the various processes being given, an arrangement which was much approved.

On the afternoon of the first day, September 5, the mayor and mayoress, Mr. J. D. and Mrs. Tyson, held a garden party in the Public Gardens, which afforded a much coveted opportunity for introductions of citizens to visitors. In the evening Sir Wm. Crookes gave his lecture on "Diamonds" in the Town Hall. Elaborate preparations had been made for the interesting experiments by which the lecture was illustrated, and these passed off most successfully. So numerous were the applications to attend the lecture that Sir William kindly repeated it the following afternoon.

On Wednesday morning, September 6, most of the visitors were taken by special train to the Du Toit's Pan and Wesselton mines, and the compound life of the natives was more minutely examined. The open workings at Wesselton enabled a more perfect idea to be formed of the methods which obtained in the older mines at the beginning of operations. During the day Alexandersfontein and Kenilworth attracted many visitors, and in the evening Prof. J. B. Porter, of McGill University, gave a lecture entitled "The Bearing of Engineering on Mining."

At mid-day on Thursday, September 7, the special trains for Bulawayo commenced to leave, and a journey which lasted until Saturday morning, September 9, introduced the travellers to many interesting scenes, many of which were of a type entirely different from any hitherto experienced. The richly wooded districts of British Bechuanaland called for frequent use of the camera, and not a few curios were purchased from the natives.

On arrival at Bulawayo, where the accommodation was limited, many of the party had to sleep in the train, a proceeding which, however, was hardly regarded as an inconvenience.

The library, which had been turned into a reception room for the occasion, brought a numerous company together, and the post-office counter was thronged for a considerable period owing to the great demand for the new Victoria Falls stamps just issued in different values. The revenue had no small gains from the sales, hundreds of sets being bought up and cancelled without being used.

In the course of the morning of September 9 Prof. Darwin opened the recently acquired museum, which on being entered was found to contain a local collection of great scientific interest. Many of the visitors expressed their regret that time was not available for a more minute study than was possible on this occasion. The afternoon was taken up by a visit to Government House, the site of Lobengula's kraal, where, in the absence of the Administrator, a reception was held by the Treasurer, Mr. Newton. Lobengula's tree of justice was a centre which all sought.

In the evening Mr. D. Randall MacIver gave a lecture-report on the "Rhodesian Ruins" which attracted a numerous audience, it having been whispered abroad that his conclusions ran counter to the theories of great antiquity which have hitherto generally held the field. Mr. MacIver's address was lengthy, and dealt chiefly with one class of evidence. Although the last word has not been said upon the subject, Mr. MacIver has certainly thrown new light upon it.

The Matopos and World's View, with the tomb of Cecil Rhodes and the Shangani monument, which called for two special trains to convey the visitors, seem to have surpassed all preconceptions, and the magnificence of the surrounding views and the quiet dignity of the last resting-place of Rhodes seem to have created the same feeling in the breast of nearly everyone present, a desire to contemplate the whole scene in the silence and solitude impossible on such an occasion. A brief religious service was conducted by the Rev. Mr. Bevan at the side of the tomb.

On Monday morning, September 11, five special trains left for Victoria Falls, and the journey through the teak forests seemed a fitting prelude to the solemn grandeur of the scenes to be viewed on the morrow.

Only some thirty hours were allotted to the falls visit, but such were the arrangements made by Sir Charles Metcalfe that the main features, both of the falls, the ravine below, and the river above, could be compassed by the energetic sightseer in the time.

The first business of the day was the opening of the new bridge by Prof. Darwin, after which Palm Kloof, Livingstone Island, the Rain Forest, and many other points of vantage and interest were visited. Not a few also enjoyed a moonlight visit to the falls, the moon fortunately being full. The next morning canoes were requisitioned for trips up the lovely island-dotted river, and the "hippos" were obliging enough to put in an appearance for the occasion. Soon after noon the special trains commenced the return trip to Bulawayo, the first stage on the journey home.

At Bulawayo the trip, which, save for a few special excursions, had been of a homogeneous character, was brought to an end. The party was here divided into two sections, the one preferring the voyage home by way of Cape Town, the other *viâ* Beira and the east coast. The latter route proved to possess the greater attractiveness, judging by the numbers who elected to return that way, which was not surprising when an opportunity of making the round journey in such circumstances was considered.

Of the visit as a whole it only remains to add that it has been a success beyond the most sanguine dreams of its promoters. The hospitality throughout has been generous to the extent of lavishness, the labour of the various local committees has been as wisely exercised as it has been unremittingly pursued, and the only regret seems to have been that the time allotted to each town was necessarily so short.

That the true interests of science both in the mother country and in the colonies have been advanced by this unique meeting of the association cannot be doubted, and the results will continue to be seen in many directions after many days.

THE BRITISH SCIENCE GUILD.

THE inaugural meeting of the British Science Guild will be held at the Mansion House on Monday, October 30; and the Lord Mayor, who has consented to preside, will take the chair at 4.15 p.m. The guild appeals to the people of Britain within and beyond the seas, and its chief object is to bring home to all classes the necessity of making the scientific spirit a national characteristic which shall inspire progress and determine the policy in affairs of all kinds. The organisation is associated with no political party, and its membership is open to all British subjects, whether men or women.

At the inaugural meeting of the guild, on October 30, the following officers will be proposed:—

President: the Right Hon. R. B. Haldane, K.C., M.P.; vice-presidents: the Right Hon. the Lord Mayor of London, Sir Lawrence Alma-Tadema, R.A., O.M., the Right Hon. Lord Balcarres, M.P., the Right Hon. the Earl of Berkeley, Sir William Broadbent, Bart., K.C.V.O., F.R.S., Sir Walter Buller, K.C.M.G., F.R.S., Sir J. Burdon-Sanderson, Bart., F.R.S., Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Sir William Church, Bart., Sir George Sydenham Clarke, K.C.M.G., F.R.S., Sir John Colomb, K.C.M.G., M.P., the Right Hon. the Earl of Donoughmore, the Right Hon. Earl Egerton of Tatton, Sir John Eliot, K.C.I.E., F.R.S., Sir Michael Foster, K.C.B., O.M., M.P., F.R.S., the Right Hon. Sir Edward Fry, F.R.S., Sir Archibald Geikie, F.R.S., Mr. F. Du Cane Godman, F.R.S., the Right Hon. Sir John Gorst, K.C., M.P., F.R.S., the Right Hon. Lord Haliburton, G.C.B., Sir Joseph Hooker, G.C.S.I., F.R.S., the Right Hon. Viscount Knutsford, G.C.M.G., Prof. Ray Lankester, F.R.S., Dr. J. Larmor, F.R.S., the Right Hon. Lord Lister, F.R.S., Sir Charles McLaren, Bart., K.C., M.P., the Right Hon. Sir Horace Plunkett, K.C.V.O., F.R.S., Mr. E. Robertson, K.C., M.P., the Right Hon. Lord Tennyson, P.C., G.C.M.G., His Grace the Duke of Wellington, K.G., G.C.V.O.; chairman of committees: Sir Norman Lockyer, K.C.B., F.R.S.; vice-chairmen: Sir William Abney, K.C.B., F.R.S., Sir Lauder Brunton, F.R.S., the Hon. Sir John Cockburn, K.C.M.G., Sir Gilbert Parker, M.P.; trustees: the Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., Sir Henry Roscoe, F.R.S.; hon. treasurer: the Right Hon. Lord Avebury, F.R.S.; hon. assist. treasurer: Lady Lockyer, 16 Penywern Road, S.W.; hon secretary: Mr. C. Cuthbertson.

A large general committee, which will include the names of the present organising committee, will also be proposed for election.

Since the first meeting, held at the rooms of the Royal Society in April, 1904, the labours of the organising committee have been directed to securing the help of representatives of all sides of the nation's activities to secure the objects of the guild, which are

(1) To bring together as members of the guild all those throughout the Empire interested in science and scientific method, in order, by joint action, to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavour, and thus to further the progress and increase the welfare of the Empire.

(2) To bring before the Government the scientific aspects of all matters affecting the national welfare.

(3) To promote and extend the application of scientific principles to industrial and general purposes.

(4) To promote scientific education by encouraging the support of universities and other institutions where the bounds of science are extended, or where new applications of science are devised.

During the first stage of the existence of the guild, the public activity of the committee was limited, by reasons of policy, because at the moment of the inception of the movement the attention of the country, and especially of Parliament, was so deeply engrossed in the fiscal problem that no other question, however important, was likely to receive due attention.

The Royal Society and British Association were founded for the promotion of natural knowledge; the Society of Arts for the encouragement of arts, manufactures, and commerce. The Science Guild, though in sympathy with these objects, is not identical in aim with any existing society. The promotion of natural knowledge is outside its sphere. Its purpose is to stimulate, not so much the acquisition of scientific knowledge, as the appreciation of its value, and the advantage of employing the methods of scientific inquiry, the study of cause and effect, in affairs of every kind. Such methods are not less applicable to the problems which confront the statesman, the official, the merchant, the manufacturer, the soldier, and the schoolmaster, than to those of the chemist or the biologist; and the value of a scientific education lies in the cultivation which it gives of the power to grasp and apply the principles of investigation employed in the laboratory to the problems which modern life presents in peace or war.

Communications may be addressed to the honorary secretary of the British Science Guild, 16 Penywern Road, London, S.W.

SIR WILLIAM WHARTON, K.C.B., F.R.S.

WILLIAM JAMES LLOYD WHARTON, second son of the late Mr. Robert Wharton, County Court Judge of York, was born in London on March 2, 1843. Educated at Burney's Academy, Gosport, he entered the Royal Navy in August, 1857, on board H.M.S. *Illustrious*, then recently commissioned as a training ship for naval cadets, stationed at Portsmouth. Passing with great credit out of the *Illustrious,* he was appointed in April, 1858, midshipman of H.M.S. *Euryalus,* on board which ship H.R.H. Prince Alfred (afterwards Duke of Edinburgh) was also serving. In November, 1860, being appointed to H.M.S. *Jason,* commissioned for service on the North American and West Indian stations, he was lent to H.M.S. *St. George,* employed on fishery duties in Newfoundland during the summer of 1861. On completing his time as midshipman he passed his examination in seamanship for the rank of lieutenant on January 13, 1863. Whilst still serving in the *Jason* he was made acting lieutenant of that ship on October 26, 1864, and at the close of the year, on the *Jason* returning to England to pay off, he at last had the opportunity to pass the examinations in gunnery and navigation necessary to qualify him for the rank of lieutenant. In these he acquitted himself brilliantly, being confirmed in his rank March 15, 1865. In December of that year he was awarded the Beaufort testimonial for passing the best examination of the year in mathematics, nautical astronomy, and navigation.

In the meantime, in July, 1865, he had been appointed to H.M.S. *Gannet,* a sloop commissioned partly for the general duties of the fleet, and partly for surveying service on the North American and West Indian stations, but acting entirely under the orders of the Commander-in-Chief. In that ship he acquired his first experience in the work to which his life was afterwards devoted, receiving the commendation of the Board of Admiralty for the zeal displayed by him on the work performed in the Bay of Fundy. The *Gannet* paid off in November, 1868.

The interest of the Commander-in-Chief, Vice-Admiral Sir James Hope, having been aroused by the ability and industry shown by Lieut. Wharton whilst serving in the *Gannet,* as well as by the distinction which he had gained in passing his examinations, when the admiral hoisted his flag at Portsmouth he offered to Wharton the appointment of flag lieutenant. The hydrographer had meanwhile promised to submit his name as second lieutenant of H.M.S. surveying vessel *Newport*; Wharton consequently considered that his services were pledged to the Surveying Service, although by adhering to it he was fully aware that he would sacrifice the prospect of certain promotion at the end of three years, but this he was prepared to do. Sir James Hope, however, took another view, and speedily arranging matters with the hydrographer, Wharton was appointed as his flag lieutenant on March 1, 1869. Whilst so employed he wrote "The History of H.M.S. *Victory,*" which still commands a steady sale to the public, the proceeds being devoted to the R.N. Seamen's and Marines' Orphans' Home, Portsmouth.

In November, 1870, H.M.S. *Urgent* being fitted out to convey astronomers to the neighbourhood of Gibraltar to observe the forthcoming total eclipse of the sun, Sir James Hope gratified his flag lieutenant by permitting him to accompany the expedition as first lieutenant of the ship. He was promoted to commander March 2, 1872, on Sir J. Hope striking his flag, and the following month saw him appointed to the command of H.M. surveying vessel *Shearwater,* first on the Mediterranean station and afterwards on the east coast of Africa. In the Mediterranean his work was chiefly distinguished by a valuable contribution to science in the form of an investigation of the surface and undercurrents in the Bosphorus, setting at rest the many controversies respecting the exhaustless flow of water from the Black Sea to the Sea of Marmora by proving that an undercurrent existed as strong as that on the surface, but which invariably flowed in exactly an opposite direction. His report, which was officially published, may be considered as prescribing the method for similar inquiries. Whilst at Rodriquez, in the South Indian Ocean, he took part in observing the transit of Venus in 1874. The *Shearwater* was paid off in July, 1875, and in June the following year he commissioned the *Fawn* for surveying service in the Mediterranean, Red Sea, and east coast of Africa. Starting with a staff of officers most of whom were wholly inexperienced, Commander Wharton set himself to train them after his own ideals, and succeeded in imbuing his assistants with something of his untiring energy and love of the work. Whilst exacting the utmost that each individual was capable of giving to the service, he exercised unremitting patience and forbearance, and throughout a prolonged commission of four and a half years endeared himself to all who had the happiness to serve under him. He was sympathetic and considerate towards both officers and men, and entered heartily into all schemes for their recreation when opportunity offered. This commission of the *Fawn* was perhaps one of the most successful, as it certainly was one of the happiest, ever spent by a surveying vessel in modern times. The last two years were occupied with the survey of the Sea of Marmora, an excellent piece of work for which he and his officers received an expression of their Lordships' approbation.

On January 29, 1880, Wharton was promoted to captain, and the *Fawn* paid off at Malta at the end of the year.

An interval of leisure then followed, during which Captain Wharton published "Hydrographical Surveying." He expresses himself with characteristic modesty in the preface, but it was at once universally recognised as the standard work on the subject, and has continued to be so considered to the present time, being used both in our own and in foreign navies.

In March, 1882, he commissioned H.M.S. *Sylvia* for surveying service in the River Plate and Straits of Magellan. It was already an open secret that he was destined to succeed Captain Sir Fred. Evans as Hydrographer to the Admiralty when that officer should retire. In December, 1882, he successfully observed the transit of Venus for the second time. The anxieties of two seasons in the inhospitable climate and dangerous waters of the western part of the Straits of Magellan told upon Wharton considerably, and at this time he aged much in appearance. But, full of energy as ever, the work was pushed on rapidly in spite of the hardships and difficulties that had to be encountered, with the result that the survey was completed within the allotted time, and on returning to Montevideo in March, 1884, he left the ship and proceeded to England by mail steamer to assume the duties of hydrographer, being appointed as such on August 1, 1884, at an age younger than that of any officer who had held that responsible position. This closed his career afloat.

Wharton's administration of the hydrographic department of the Admiralty continued uninterruptedly for twenty years with constantly increasing credit, and to the great advantage of our own Navy as well as to the whole maritime world. This period covered the enormous expansion that took place both in the *personnel* and *materiel* of the fleet, causing corresponding accessions to the labour of departmental work; during the same period the number of chart plates was largely increased, and the number of charts printed annually for the fleet and for sale to the public multiplied three-fold.

Gifted with an extraordinary capacity for work, he never spared himself; the sound judgment, breadth of view, and wide scientific attainments constantly brought to bear upon the infinite variety of subjects with which he was daily called upon to deal secured for him the respect and confidence of successive Boards of Admiralty. An especial characteristic was the readiness with which the mass of information he had acquired on all sorts of subjects was available on the spur of the moment. As *ex-officio* member of the Meteorological Council, he attended its meetings assiduously and rendered valuable service to the advancement of ocean meteorology.

His personal interest in the surveying service was unceasingly manifested in the voluminous semi-official correspondence he maintained with the officers in command of surveys. Scientific subjects of whatever nature bearing on hydrography always claimed his attention, and in 1886 he was elected a Fellow of the Royal Society, serving on its council from 1888 to 1889, again from 1895 to 1897, and being again elected in 1904 was a member until his death.

As Fellow of the Royal Astronomical Society, as well as of the Royal Geographical Society, as vice-president of the latter and member of numerous committees, he did work only less important than his official work at the Admiralty. His first contribution to the literature of the Royal Society was the investigation of the great waves produced by the eruptions of Krakatoa in 1882, which had been begun by the late Sir Frederick Evans and left unfinished at his death. In 1893 he edited the journal of Captain Cook during his first voyage round the world; at the meeting of the British Association at Oxford in 1894 he presided over Section E. Various contributions to NATURE appeared from time to time from his pen, the investigation of the origin and formation of coral reefs being a subject of especial interest to him. He advanced a theory, based upon the results of surveys of large numbers of these reefs, that the effect of wave action was mainly accountable for the striking uniformity of depth so frequently met with over the interior of coral banks in the open ocean, showing that wave action in open oceans extended to greater depths than was hitherto considered possible.

As a member of the coral reef committee of the Royal Society, he was largely responsible for the selection of Funafuti as the atoll to be investigated by sounding and boring operations, and he was instrumental in securing the cooperation of the Admiralty in the work, which has produced such valuable results.

He was keenly interested in the project for Antarctic exploration, but more particularly in its bearing upon terrestrial magnetism, and he took a very active part as a member of the joint committee of the Royal and Royal Geographical Societies appointed to organise it.

He was placed on the retired list in 1891, in accordance with the regulation respecting non-service at sea. Promoted to Rear-Admiral on January 1, 1895, on the Queen's birthday that year he was nominated as C.B. On the occasion of the Diamond Jubilee in 1897 he was created K.C.B.

On July 31, 1904, Sir William Wharton resigned the office of hydrographer. For some years previously he had suffered much inconvenience and pain owing to an injury to his right wrist received whilst serving in the *Shearwater*; for this and other causes he determined to relinquish the appointment. In July last, after a visit to Aix-les-Bains, he accepted with some hesitation the reiterated invitation to go out to South Africa with a party of members of the British Association, and he presided over Section E at Cape Town. Unfortunately he fell ill on the return journey from the Victoria Falls, and could not return to England as he intended, with his friends, in the *Armadale Castle*. His illness, which was at first thought to be a chill, proved to be enteric fever complicated with pneumonia, and although no effort was spared to effect his recovery he died at the observatory at Cape Town on September 29, where he was the guest of his old and valued friends Sir David and Lady Gill. He was buried at the Naval Cemetery at Simon's Town on October 1 with full naval honours, H.M. the King being represented by the Commander-in-Chief of the station. He was married, in 1880, to Lucy Georgina, daughter of Mr. Edward Holland, of Dumbledon, in Gloucestershire, and by her, who survives him, he had two daughters and three sons, two of whom are now serving in H.M. Navy.

A. M. F.

GEORGE BOWDLER BUCKTON, F.R.S.

ONE of the most energetic and laborious, as well as one of the oldest of our British entomologists, Mr. George Bowdler Buckton, died on September 25 in his eighty-eighth year. Although he was always interested in natural history, it is somewhat remarkable that, while many men take up the study of entomology in early life and abandon it later, all his important entomological work was executed late in life, and was carried on until a very short period before his death.

Mr. Buckton was born at Hornsey on May 24, 1818. He was privately educated, being debarred from entering a public school by an accident in boyhood which crippled him for life.

Mr. Buckton dedicated his first book, "British Aphides," to Thomas Bell, "a friend of more than forty years' standing" (in 1876), whose sympathy and encouragement had given him a taste for natural history. During the earlier part of his life Mr. Buckton resided in or near London, when his attention was given more to physical than to natural science; and he served as assistant to Prof. A. W. Hofmann at the Royal College of Chemistry. From 1845 to 1865 he published several important papers on chemical subjects (a list of which will be found in the Royal Society's Catalogue of Papers) in the *Journal of the Chemical Society*, the *Proceedings of the Royal Society*, and elsewhere; and his earliest published paper on any entomological subject appears to have been "On the Application of Cyanide of Potassium to killing Insects for the Cabinet," published in the *Zoologist* for 1854, cyanide compounds having been one of his favourite studies during his chemical researches. In the following year (1855) he published a short paper on bats in the second volume of the *Proceedings of the Linnean Society*.

He was a Fellow of the Linnean Society (1845), the Chemical Society (1852), the Royal Society (1857), and the Entomological Society (1883), and was also a member of the Entomological Society of France, a corresponding member of the Royal Academy of Sciences of Philadelphia, &c. He took great interest in these societies, attending their meetings as far as he was able, and occasionally serving on their councils; he also travelled in Italy, France, and other Continental countries, as well as in the British Islands.

In 1865 Mr. Buckton published one of the last of his chemical papers, in conjunction with Prof. W. Odling, whose daughter, Mary Ann, he married in the same year. He then settled at Haslemere, Surrey, for the remainder of his life, where he had purchased the estate at Weycombe, and built himself a house after his own design, with an observatory.

From the time of his residence at Haslemere, Mr. Buckton devoted much of his time to entomology. He formed a collection of Lepidoptera, but paid more attention to the British Homoptera, being much assisted by his children, whom he brought up in the same tastes as his own. He wrote comparatively little in the entomological journals, but published a series of very important entomological monographs from 1876 to 1905, chiefly relating to the somewhat neglected order Homoptera, which will not soon be superseded. They may here be enumerated:—1876–1883, "Monograph of British Aphides" (Ray Society), 4 vols., comprising upwards of 750 pages of letterpress, 9 plain and 134 coloured plates; 1890–1891, "Monograph of British Cicadæ or Tettigidæ" (Macmillan), 2 vols., comprising 426 pages of letterpress, 7 plain and 75 coloured plates; 1895, "The Natural History of *Eristalis Tenax*, or the Drone-Fly" (Macmillan), 1 vol., pp. vii+88, with 1 coloured and 8 plain plates. This work is illustrative of the story of Samson and the Bees. 1901–1903, "A Monograph of the Membracidæ" (Lovell Reeve), 6 parts, comprising upwards of 300 pages of letterpress, and 1 plain and 60 coloured plates. Mr. Buckton's last publication was a supplementary paper to this work, comprising 10 pages of letterpress and 2 coloured plates, forming vol. xi., part ix., of the *Transactions of the Linnean Society*, second series, zoology, and dated July, 1905.

The illustrations to Mr. Buckton's works were all drawn, and the pattern plates coloured, by himself. Some of his plates were even lithographed by himself, and most, if not all, of those which were hand-coloured were coloured by himself or his daughters. The original drawings for the work on Membracidæ have been presented to the Hope Museum at Oxford.

Mr. Buckton kept his genial force and vitality to the end; "his eye was not dimmed, nor his natural force abated." His last illness was of brief duration, and the end was very calm and peaceful. His ashes, after cremation, were deposited in a grave lined with ivy leaves in Haslemere Churchyard on Saturday, September 30.

W. F. Kirby.

NOTES.

We regret to see the announcement that Ferdinand Baron von Richthofen, professor of geography in the University of Berlin, died on October 7 in his seventy-third year.

The sixth annual Huxley memorial lecture of the Anthropological Institute will be delivered on Tuesday, October 31, in the rooms of the Society of Arts, by Dr. John Beddoe, F.R.S., the subject being "Colour and Race."

A joint meeting of the Royal Society and the Royal Astronomical Society will be held in the rooms of the Royal Society on Thursday next, October 19, at 4.30 o'clock, to receive preliminary reports on the observations of the recent solar eclipse. It is expected that reports will be presented by the Astronomer Royal, Prof. H. L. Callendar, Mr. J. Evershed, Mr. H. F. Newall, Prof. H. H. Turner, and others.

The annual "fungus foray" of the Essex Field Club will be held at High Beach, Epping Forest, on Saturday next, October 14; referee, Mr. George Massee, of Kew Museum. Any botanists wishing to attend should communicate with the hon. secretaries of the club, Buckhurst Hill, Essex.

The death is announced of the Rev. S. J. Johnson at his residence, Melplash Vicarage, near Bridport, on October 9. Mr. Johnson was well known in astronomical circles for his writings upon eclipses and other astronomical matters. He was a Fellow of the Royal Astronomical Society for more than thirty-three years.

Sir Edward H. Carbutt, the eminent mechanical engineer, died suddenly at his residence near Guildford on October 8 at the age of sixty-eight years. He was a past-president of the Institution of Mechanical Engineers, and a vice-president of the Iron and Steel Institute. He was an active member of the board of the National Physical Laboratory, and represented the Iron and Steel Institute on the departmental committee on the Royal College of Science and Royal School of Mines. He also represented the Iron and Steel Institute on the Institution of Civil Engineers' committee to formulate a scheme of education for engineers.

The Municipal Museum at Hull recently acquired a valuable addition to its collection of local Roman and other remains. The specimens are principally of Roman date, and include more than 2000 coins, nearly 100 fibulæ of a great variety of patterns, several dozen buckles, pins, dress fasteners, ornaments, strap ends, bosses, spindle whorls, armlets, spoons, beads, and other objects. Among the fibulæ are two of exceptional interest, as they bear the maker's name upon them (Avcissa). There is also an extensive collection of pottery, including many vases, strainers, dishes, &c., in grey ware, as well as many fine pieces of Samian ware, several of which contain the potters' marks.

AT the meeting of the Institution of Civil Engineers on Tuesday, November 7, an inaugural address will be delivered by the president, Sir Alexander R. Binnie, and the council's awards will be presented. In addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, the council of the institution has made the following awards in respect of other papers dealt with in 1904–5:—a George Stephenson medal to Captain H. R. Sankey, R.E., a Watt medal to Dr. C. Chree, F.R.S.; Telford premiums to Messrs. W. E. W. Millington, C. E. Stromeyer, C. W. Hill, F. C. Lea, W. B. Cole, W. C. Popplewell, E. H. Rigby, and W. O. Leitch, jun. For students' papers the awards are:—Miller prizes to Messrs. A. B. Potts, W. M. Hayman, R. E. Bury, T. Lees, jun., T. L. Matthews, P. J. Risdon, and F. E. Tudor.

THE organisation and methods of the Japanese Naval Medical Service recently formed the subject of a communication by Surgeon-General Suzuki to the Association of Military Surgeons at Detroit. Much of the success achieved in the treatment of wounds was ascribed to a regulation requiring every member of the crew of a warship before battle to bathe and dress in perfectly clean underclothing. During engagements a 1 per cent. solution of boric acid was provided to wash the eyes free from powder, smoke, and dust, and cotton-wool plugs for the ears were issued to every man. It was impracticable during action to attempt anything but the most necessary first dressing of wounds, and after action, wherever possible, the wounded were hurried to the base hospital, and only the absolutely essential operations performed on the spot.

RECENT issues of the *Proceedings of the Philadelphia Academy* include two papers on polychætous annelids from the North Pacific by Mr. J. P. Moore, and notes on Hawaiian land shells of the families Achatinellidæ and Endodontidæ by Messrs. Pilsbry and Vanatta.

AN addition to the useful little guides to the contents of the Horniman Museum at Forest Hill has been issued by the London County Council in the form of "Handbook to the Marine Aquaria," and offered for sale, like all its fellows, for one penny. The handbook commences with an account of the manner in which such receptacles may be made and stocked, followed by notes on some of the common animals which may be kept therein.

WE have received part ii. of the ninth volume of the *Transactions of the Leicester Literary and Philosophical Society*, containing the report of the council for the past year. Several lectures, of some of which brief abstracts are published, were delivered during the period under review, and the council reports not only an increased attendance at these lectures on the part of the public, but likewise a successful session as a whole.

A SMALL case has been placed on one of the walls in the central hall of the Natural History Museum for the purpose of showing that the habit of depositing its eggs in the nests of other birds is not confined to the common cuckoo, and that some kinds of cuckoos hatch their own eggs. Among the series is an egg of a cow-bird among a clutch of eggs of a tyrant-bird. In this case the dissimiliarity between the eggs of the two species is very marked, but in a clutch of magpies' eggs among which is an egg of the great south European cuckoo the resemblance is marvellously close.

TO the October issue of *Bird Notes and News* Dr. E. A. Wilson, late naturalist on the *Discovery*, contributes an interesting note on penguins, especially with regard to the wholesale destruction of these birds in certain districts for the sake of their oil. As regards the Antarctic species, which are at present unmolested, the author is of opinion that the emperor penguin is secure from attack during the breeding-season, although at other times of the year its destruction could be encompassed, as could that of the Adélie penguin at all seasons. Articles on the protected breeding resorts of gulls and terns in Lancashire and Lincolnshire are included in this number.

THE early history of that exterminated race the Morioris of the Chatham Islands forms the subject of two papers in the *Transactions of the New Zealand Institute* for 1904. The author of one of these is of opinion that there was an immigration of Polynesians into New Zealand antecedent to the arrival of the Maories, and it is suggested that the Morioris came among these earlier voyagers. Among a number of zoological papers in the same volume reference may be made to three by Prof. Benham on the earthworms of New Zealand and the Kermadecs, in the course of one of which the author requests that observers will forward specimens from all parts of that area. Attention is directed by Archdeacon Walsh to the alleged existence in New Zealand of an undescribed lizard or salamander. To the geological section Captain Hutton communicates three papers, one on the formation of the Canterbury plains, a second on certain new Tertiary shells, and a third on the Tertiary brachiopods.

"THE CAMBRIAN FAUNA OF CHINA" forms the title of a paper by Mr. C. D. Walcott constituting No. 1415 of the *Proceedings of the U.S. National Museum* (vol. xxix., pp. 1–106). The existence of Cambrian fossils in China was announced in 1883 by Baron von Richthofen, while other specimens were described in 1899. Two years ago the Carnegie Institution of Washington dispatched an expedition for the purpose of obtaining a representative collection of these fossils, and the paper before us is a preliminary account of the collection then made. The fossils of this epoch in China have proved to be extraordinarily abundant, as is indicated by the circumstance that imperfect specimens are scarcely taken into account in this preliminary notice. Brachiopods and trilobites appear to be the dominant forms, and it is confidently expected by the author that important results will follow thorough and systematic exploration and collecting.

TWO out of the three articles in the September issue of the *American Naturalist* are of a somewhat technical nature, and interesting to the specialist rather than the general naturalist. In the first Mr. H. Crawley discusses the complex question of the interrelations of the parasitic protozoans of the group Sporozoa, as typified by the gregarines; while in the second Mr. F. C. Baker describes the reproductive organs of the pond-snails of the genus Limnæa. In the third and more popular article Miss Worthington supplies a large amount of information with regard to the life-history of hag-fishes, or myxinoids. These fishes abound in Monterey Bay, where they are taken on the rock-cod beds at a depth of about 300 feet. They live curled around and between the rocks, and when in health always assume a coiled position. Although they will stand much rough treatment, a decided rise of temperature proves fatal. They do much damage by stripping the flesh off fish hooked on the lines. In feeding, the tooth-plate is thrust out of the mouth, with its two halves divergent, and the flat surface pressed against the fish and the two halves brought together, thereby tearing off a piece of flesh, which is withdrawn into the mouth.

In part i. of the fifth volume of the *Proceedings of the Rhodesia Scientific Association* are contained three papers by the president, Mr. Franklin White. Two of these are descriptions of ruins; the more important paper deals with Zimbabwe on the same lines as the more detailed account in the next issue of the *Journal of the Anthropological Institute*; the illustrations are different. Mr. White's very careful survey shows that many of the data on which have been based theories as to the age and use of the ruins are untrustworthy, and it is unfortunate for him that the negative results of his really sound work have now been overshadowed by the more positive contributions of Mr. MacIver's excavations. The third paper deals with bushman cave paintings near Matopos, and is of interest as showing their occurrence in an area outside that allotted to the "painters" in Stow's recent work; the paintings are reproduced in four coloured plates. Other illustrations in this part show the Lumene and Umnukwane ruins. Few local societies do more useful work than does the Rhodesian Scientific Association, and its *Proceedings* do it great credit.

In the *Naturwissenschaftliche Wochenschrift* for August 13 will be found a *résumé* of our knowledge of carpospore formation in the red seaweeds, which formed the subject of an address by Dr. F. Tobler to the Gesellschaft naturforschender Freunde of Berlin. The article, which deals with the work of Oltmanns and his predecessors, is illustrated with a selection of their figures.

In 1879 Prof. F. C. Schubeler, of Christiania, published some conclusions which he had formed regarding the greater productiveness and quicker ripening qualities of grain sown in northerly districts or on highlands as compared with that sown further south or on lowlands. These conclusions were not without value, as they directed attention to the matter, but Prof. N. Wille questions their accuracy in the *Biologisches Centralblatt* (September 1). Data compiled by Mr. L. P. Nilssen for different Norwegian districts tend rather to show that crops take longer to ripen near the sea than further inland.

The pages of the *Indian Forester* contain a number of useful short notes and letters contributed by officers of the Indian Forest Department, in which they record their experiences and exchange opinions. In the July number Mr. W. Mayes describes a disastrous outbreak of *Trametes pini* in the forests of *Pinus excelsa* in the Simla division; he proposes to replace the diseased poles with deodar, which is believed to be immune to this fungus. A simple but effective method of holding shifting sands by planting thorn hedges is described by Mr. L. Das. The subject of fire protection in teak forests has elicited various expressions of opinion.

The report of the industrial section of the Indian Museum, Calcutta, for the year 1904–5 has been received from the acting superintendent, Mr. Hooper. Among the recent additions to the economic section, the fragrant resin or balsam furnished by *Altingia excelsa*, the dammar-resin secreted by the Melipona or mosquito bee—both products of Burma—and a white resin from Assam, yielded by *Dipterocarpus pilosus*, are of special interest, and have been examined in the laboratory. From Burma specimens have also been sent to the art ware and ethnological sections, but the latter has been augmented principally by collections from Nepal and Tibet of musical instruments, articles of warfare, and personal ornaments.

Although at first glance the disposition of the Lower Palæozoic strata of the Island of Montreal, dipping at a very gentle angle away from the Laurentian plateau, might appear to promise a constant source of artesian water, the mineral character of the rocks forbids this. They are chiefly massive limestones, and the underground water travels along fissures and not in any special water-bearing beds, so that the success or failure of a boring cannot be foretold. Such is the conclusion reached by Prof. Adams and Mr. Leroy from a study of eighty-nine wells (Geological Survey of Canada, annual report, 1904, part O). Their report includes a general account of the geology of the Montreal district, illustrated by an excellent map on the scale of four miles to the inch, so that the pamphlet will be of interest to many who have no concern with well-sinking.

We have received from Dr. P. Bergholz a copy of the observations taken at the Bremen Meteorological Observatory during 1904. The work forms one portion of the excellent series of the "German Meteorological Yearbooks," and contains hourly values and means of the principal elements, together with the daily ranges and other useful tables. It may be remembered that Dr. Bergholz translated into German Father Viñes's very valuable work on the circulation and translation of the cyclones of the West Indies, published in 1895, some two years after the lamented death of the author.

Mr. A. Linton, Director of Agriculture for British East Africa, has published the meteorological records of that protectorate for the year 1904. It is admitted that the observations are not so satisfactory as might be, owing to want of sufficient instruments and of uniformity of exposure, but steps are being taken to remedy both these defects in the near future. The report, however, contains valuable records (mostly of rainfall) at twenty-eight stations, taken at 9h. a.m., during the year 1904, together with monthly and yearly means for as long a period as available, in some cases exceeding ten years. The amount of rainfall varies considerably, according to geographical position; in some provinces the crops suffer from lack of sufficient quantity and in others from excess. The yearly average seems to vary from about 14·7 inches at Kismayu to 73·4 inches at Mumias; both stations are practically in the latitude of the equator, the former station being at 43° E. long., near the sea-level, and the latter at 34° E. long., at an altitude of about 4000 feet.

The large part which her system of secondary and higher education has taken in Germany's extraordinary industrial success forms the subject of an article by Mr. J. L. Bashford in the current number of the *Fortnightly Review*. The essay summarises arguments which have been urged on many occasions in these columns, and advocates forcibly the need for the provision of a generous supply of higher education of the right kind, if Britain is to regain her position in the world of commerce. It is satisfactory to find a growing disposition on the part of the general Press to explain the shortcomings of our national education and to demand the provision of more funds for higher education. The same number of the review contains two other articles of interest to men of science. Dr. C. W. Saleeby, under the title of "The

Problems of Heredity," reviews at length Mr. Archdall Reid's recent book on the subject, and Miss Harriet Munroe gives a picturesque account of a visit to Walpi to study the snake dance.

FROM a study of the spectra of alloys of different metals, photographed under varying conditions of electrical excitation, atmosphere, and the proportions of the components, Mr. P. G. Nutting, of the Washington Bureau of Standards, has arrived at some interesting conclusions which confirm and supplement the results obtained by Lockyer and Roberts in 1873. Mr. Nutting's researches are described in No. 2, vol. xxii., of the *Astrophysical Journal*, and the results may be summarised as follows:—The spectra of the component metals are independent of one another when the alloy is volatilised by either the arc or the spark. The relative intensities of the component spectra are unaffected by variations of the electrical conditions or by substituting hydrogen, oxygen, mercury vapour, &c., for air as the surrounding atmosphere. *Ceteris paribus*, the spectrum of the component which has the greater atomic weight will be the brighter, when inductance is used, either with the arc or with the spark. Under certain conditions—which the author enumerates—spectroscopic analysis of alloys to within an error of about 5 per cent. should be practicable. Mr. Nutting further states that, in practice, the presence of impurities in the electrodes is of little consequence, and that when alloys are used as electrodes it is useless to attempt to intensify the spectrum of either component by varying the conditions under which the arc or spark is produced.

THE American Academy of Arts and Sciences has published a pamphlet giving a brief historical account of the origin of the Rumford fund. This fund had its origin in the gift by Count Rumford—who was born at Woburn, Massachusetts—to the American Academy of Arts and Sciences of the sum of 5000 dollars, which was simultaneous with the gift of a like sum, 1000*l.*, to the Royal Society. The purpose of the fund was the same in each case, the award of a suitable premium for discoveries or improvements in heat and light. The gift was accepted by the academy, but for many years no award of the premium was made, as no claimant appeared whose merit was such in its opinion as to justify this. Meanwhile, the fund had accumulated to the amount of 4000*l.*, and in view of the fact that there was no possibility of expending the income in the precise manner contemplated by Count Rumford, application was made in 1831 to the Supreme Court of the Commonwealth of Massachusetts for relief, if such should be possible. The court issued a decree which modified the possible disposition of the income of the fund in such a manner as to increase its usefulness while keeping entirely within the spirit of the original gift. At the close of the last fiscal year of the academy (1904–5) the Rumford fund amounted to 11,744*l.*, the income for that year having been 510*l.* A standing committee of the academy known as the Rumford committee is charged with the supervision of the trust, and considers all applications for the Rumford premium and all applications made for grants in aid of research. The Rumford committee was first constituted a standing committee in 1833. Its members were nominated annually by the president of the academy until 1863, since which time they have been chosen in the same manner as the other officers. The Rumford fund of the Royal Society has been devoted solely to the award of the premium according to the original provisions of the trust.

OUR ASTRONOMICAL COLUMN.

FURTHER ECLIPSE RESULTS BY FRENCH OBSERVERS.—In No. 13 (September 25) of the *Comptes rendus* M. Salet publishes the preliminary results obtained by his expedition at Robertville (Algeria) during the recent total solar eclipse.

M. Salet was in charge of the mission sent to this station by the Bureau des Longitudes, the chief purpose being to make researches regarding the polarisation of the coronal light.

The first point investigated was the existence of a magnetic field in the neighbourhood of the sun, the presence of such a field being evidenced by the deviation of the plane of polarisation of the coronal light. The result indicated that there is a very slight deviation, amounting to about 2°.5, which seems to show that in spite of its great mass the sun has only a small magnetic field.

A photographic study of the distribution of the polarised light of the corona showed the bands of polarisation decreasing regularly in intensity to about one and a half diameters from the solar limb. The maximum of intensity occurs at about 5′ or 6′ from the limb, and from this distance the bands extend into the inner corona, diminishing in intensity as they approach the edge of the moon. A prominence extending across two bands shows no difference of intensity, thus proving the non-polarisation of these features of the solar atmosphere.

In order to test the atmospheric polarisation, two Savart polariscopes were pointed 90° from the sun, the one towards the pole, the other towards the equator. At this distance the quantity of polarised light during totality was insufficient to observe, although at 30° or 40° from the sun the bands remained visible throughout the period of totality.

To determine the coronal, chromospheric, or atmospheric nature of the corona spectrum lines, a "nicol" was placed so that it covered half the slit of a spectroscope and entirely extinguished the radially polarised light which is *reflected* by the corona. The resulting negative showed that the continuous spectrum of the corona differed in intensity on its two edges because of the suppression of the reflected sunlight, but the light from a prominence showed no diminution in intensity after passing through the "nicol."

The coronium line, which extends to about 4′ from the sun, is seen on both edges, as are the two calcium lines, but the latter are stronger on the edge containing the prominence.

The ultra-violet region of the spectrum, between λ 338 and λ 305, was also photographed, and shows about fifteen lines of which the nature and wave-lengths have yet to be determined.

COSMICAL EVOLUTION.—Some interesting results concerning the processes of cosmical evolution are given in a mathematical discussion, by Mr. J. H. Jeans, of Cambridge University, which appears in No. 2, vol. xxii., of the *Astrophysical Journal*.

The author first directs attention to the extremely small densities usually obtained for such binary systems as that of Algol, and points out that these densities are incompatible with the assumption that such systems are composed of incompressible homogeneous fluids; but the discussions concerning the mechanics of such systems are primarily based on this assumption, and are, therefore, in Mr. Jeans's opinion, deprived of any foundation of fact.

Mr. Jeans then discusses the probable mode of evolution of stellar and planetary systems, and arrives at the conclusion that "gravitational instability" plays the principal part in the segregation of systems from the original nebula.

He contends that Laplace's "rotation" theory of cosmical evolution only takes into account a secondary factor in the process, and, in support of the "gravitational instability" theory, he shows that before rotation alone could effect the birth of a satellite a nebulous mass of, say, $10^{33 \cdot 3}$ grams would have to contract until its linear dimension was about $10^{-34 \cdot 5}$ cm., *i.e.* until its density was about 10^{137}.

If the material of the original nebula could be considered as consisting of solid particles such as are assumed in the meteoritic hypothesis, each meteorite forming a molecule of a quasi-gas, the rotational theory would become more tenable.

VISIBILITY OF FAINT STARS AT THE LOWELL OBSERVATORY.—In No. 7, vol. xiii., of *Popular Astronomy*, Mr. Lowell publishes a chart and some figures which testify eloquently to the "seeing" and the instrumental efficiency at the Lowell Observatory, Flagstaff, Arizona.

In going over a chart of faint stars published by Prof. Tucker for magnitude comparisons, Mr. Lampland found that the faintest stars on the Lick chart were perfectly visible at Flagstaff, although the aperture employed there is only 24 inches, whereas at Lick an aperture of 36 inches is available. In the region following δ Ophiuchi, one of Prof. Tucker's richest fields, 161 stars were shown on the Lick chart. Plotting the same field, independently, Mr. Lampland obtained 173 stars, the greatest increase occurring among the fainter objects. As 15 stars marked on the Lick charts were not found, it follows that 27 were actually seen at Flagstaff which were not recorded by Prof. Tucker. Mr. Lowell remarks that this result is not definitive of what may be charted at his observatory, as moonlight and the rainy season both acted as drawbacks in the present test.

THE ORBIT OF ζ TAURI.—The spectroscopic binary ζ Tauri was included in a list of such objects published by Profs. Frost and Adams in vol. xvii. of the *Astrophysical Journal*, and attention was then directed to the peculiar spectrum of this star. Because of this peculiarity, and also on account of its long period, this object has since been observed regularly at the Yerkes Observatory, and Prof. Adams has determined the orbit, the determination being based on the measurements of the line Hγ on twenty-five plates. Owing to the great breadth of this line duplicate measures were made throughout, and, with the exception of one plate, which was rejected in the discussion, they agreed reasonably well.

The following elements were obtained as a result of the research:—

$u_1 = 100° 13'$	$a \sin i = 27,900,000$ km.
$\omega = 9° 45'$	Period U = 138 days
$e = 0·180$	$\mu = 2°·609$
T = 1902 Jan. 19·9	

The largest residual is −3.1 km., which, considering that the determination is based upon the measurements of only one line, is regarded as satisfactory. No trace of the spectrum of the second component has been found on any of the plates yet secured (*Astrophysical Journal*, September).

THE CONSTANT OF ABERRATION.—As the result of a laborious discussion of more than 15,000 observations, Prof. Doolittle has arrived at the value 20″·54 for the constant of aberration. In publishing this result Prof. Doolittle states that no reasonable weighting of the values will alter it more than 0″.01. The above value agrees very well with the statement made in 1903 by Prof. Chandler, after a very complete investigation, that the real value would be found to be 20″.52, or slightly higher (the *Observatory*, No. 361).

THE NATAL GOVERNMENT OBSERVATORY.—Mr. Nevill's report of the work done in the Natal Government Observatory during 1904 contains but few references to purely astronomical observations, the chief function of the observatory being distinctly meteorological.

THE OPENING OF THE MEDICAL SESSION IN LONDON.

AS is customary, the opening of the medical session has been made the occasion at several of the schools for the distribution of prizes and the delivery of interesting addresses.

At University College, Prof. Kenwood gave an address on "Preventive Medicine, Past and Present," in the course of which he directed attention to the important position occupied by medical practitioners as guardians of the public health, and emphasised the necessity for the adequate teaching of hygiene and public health in the medical schools. He then dealt with the condition of things which should obtain in a hygienic Utopia, and pointed out that while typhus fever had been practically banished and the mortality from scarlatina reduced 80 per cent. during the past thirty years, that from measles had increased. As regards the statement that the practice of hygiene and preventive medicine tends to the preservation of the physically unfit, there is doubtless both a credit and a debit side to the account, and there can be little doubt that the credit side presents a splendid balance.

At King's College the session was opened by Prof. Clifford Allbutt, F.R.S., with an address on "Medical Education." Prof. Allbutt said that in medical education London had its own problems and difficulties, but these could only be solved on principles common to education everywhere and always.

Education must always consist of two parts—the earlier a drawing forth and refining of all the faculties and such a formation of them as habits that a right reason and virtue became easy and pleasant to us; the later the adaptation of these faculties to particular callings. The methods of specific or technical educations were pretty clearly seen; their difficulty was only the difficulty of persuading the British parent of the value of any education whatever, and of the importance of providing for it money, equipment, and time.

The university should be responsible only for a certain universal character of the mind and imagination, a training which could be given in any one of many "faculties." The five years' professional course, all too brief as it was, was now much too heavily loaded. The preliminary sciences occupied so far the larger half of it that little more than a year and a half had to suffice for the study of medicine in all its divisions and subdivisions; and yet upon that formidable burden of subjects some enthusiasts were yearning to pile more and more. The reform which was needed was to teach fewer subjects and to teach them broadly and accurately. In the five years' technical course we ought to begin with the two subjects anatomy and physiology, and teach them on university methods. No subjects made a finer training for hand and mind.

At St. George's Hospital the introductory address was delivered by Mr. Brudenell Carter, who also dealt with medical education and the importance of research. He expressed the opinion that a real and thorough training in physics should form, and eventually must form, the essential groundwork of medical education. Next in importance to physics, as a preliminary subject, he would place such a study of language, it may be of one language alone, as would enable the learner to form clear ideas himself and to express those ideas in a manner clearly intelligible to others.

At Charing Cross Hospital, Sir James Crichton-Browne delivered one of his characteristic addresses. He declared that we have hordes of undergrown, underfed, blemished, diseased, debilitated men, women, and children, who are industrially and socially inefficient; that many of our public institutions are as incompetent as the valves of a damaged heart, and that our educational machinery, our economic system, our municipal administration, and our Army are all inefficient.

If they were to be efficient medical men they must improve their personal efficiency, and see to it that they were physically efficient, intellectually efficient, and morally efficient. For facilitating the attainment of these desirable ends Sir James formulated a series of precepts or principles by which they should be guided.

He dwelt on the necessity for proper exercise and recreation, for proper meals, and for a sufficiency of sleep, declaring that the medical student should have regularly nine hours' sleep in the twenty-four.

At the Middlesex Hospital, Dr. R. A. Young took for his theme "Method in Medicine," and dealt with the need for method in teaching and in study, in research and in practice.

At St. Mary's Hospital an address on "The Public and Medical Education" was given by Dr. Wilfred Harris, in which he stated his conviction that concentration of teaching in the preliminary and intermediate subjects at one or a few centres would make for efficiency, and that one State-controlled examination should take the place of the present multitude of degree and diploma-giving bodies.

Mrs. Bryant, in the course of an address on "Ideals of Study" at the London School of Medicine for Women, said that an ideal of study was most usefully conceived, not as a scheme of learning to be achieved, but rather in its psychological essence as growing out of the primitive intellectual interests of human beings. Interest in knowledge for its own sake—the theoretic interest—was to be found more or less in every healthy normal person. According to brain type, habit, association, and other circumstances, its bent towards one or another branch of knowledge varied in individuals.

It was suggested that more should be done in elementary and secondary education (1) to develop the practical interest in relation to all the every-day problems arising naturally in the environment; and (2) to train it to a high ideal of the science and skill involved in their solution. The neglect of the practical interest in the practically minded was not only loss of good material for practical efficiency; it was also the loss of opportunity for the cultivation of the scientific interest. To inquire how a thing was made led to inquiry as to its causation, and at that point the youth or child becomes athirst for science.

At the London School of Tropical Medicine, Dr. George Nuttall, F.R.S., delivered an address on "Scientific Research in Medicine," in the course of which he pointed out the great benefits to mankind which have followed such discoveries as those of the causes and prevention of yellow fever and malaria, and that the majority of such discoveries have been made by those engaged in research and in the realms of pure science, and rarely by those guided by principles of direct and immediate utility. He urged the necessity for the endowment of research, particularly in experimental medicine, and finally proceeded to review recent work in protozoology and parasitology.

At the School of Pharmacy, Pharmaceutical Society of Great Britain, Sir Boverton Redwood delivered the address on "General Study and Specialism," and at the Royal Veterinary College Mr. Hunting discussed the career of members of the veterinary profession.

DIAMONDS.[1]

FROM the earliest times the diamond has fascinated mankind. It has been a perennial puzzle—one of the "riddles of the painful earth." It is recorded in "Sprat's History of the Royal Society" (1667) that among the questions sent by order of the society to Sir Philiberto Vernatti, resident in Batavia, was one inquiring "Whether Diamonds grow again after three or four years in the same places where they have been digged out?" The answer sent back was "Never, Or at least as the memory of man can attain to."

Of late years the subject has fascinated many men of science. The development of electricity, with the introduction of the electric furnace, has facilitated research, and I am justified in saying that if the diamond problem is not actually solved, there is every probability it shortly will be solved.

South Africa, as I will show in detail, is the favourite haunt of diamonds on this planet: it ranks with Australia and California as one of the three great gold-yielding regions. But the wealth of South Africa is not limited to gold and diamonds. It is also the illimitable home of coal—"the black diamond" of the universe. The province of Natal alone contains more coal than Britain ever owned before a single bucket had been raised; and the coal beds extend into the Orange River Colony. Valuable iron ores exist also in large quantities.

The Pipes at Kimberley.

The five diamond mines are all contained in a precious circle 3½ miles in diameter. They are irregular shaped round or oval pipes, extending vertically downwards to unknown depths, retaining about the same diameter throughout. They are considered to be volcanic necks, filled from below with a heterogeneous mixture of fragments of surrounding rocks, and of older rocks such as granite, mingled and cemented with a bluish coloured hard clayey mass, in which famous blue clay the imbedded diamonds are hidden.

How the great pipes were originally formed is hard to say. They were certainly not burst through in the ordinary manner of volcanic eruption, since the surrounding and enclosing walls show no signs of igneous action, and are not shattered or broken up even when touching the "blue ground." It is pretty certain these pipes were filled from below after they were pierced, and the diamonds were formed at some previous time and mixed with a mud volcano, together with all kinds of débris eroded from the rocks through which it erupted, forming a geological "plum pudding." The direction of flow is seen in the upturned edges of some of the strata of shale in the walls, although I was unable to see any upturning in most parts of the walls of the De Beers mine at great depths.

The breccia filling the mines, usually called "blue ground," is a collection of fragments of shale, and of various eruptive rocks, boulders, and crystals of many kinds of minerals. Indeed, a more wildly heterogeneous mixture can hardly be found anywhere else on this globe. The Kimberley mines for the first 70 feet or 80 feet are filled with so-called "yellow ground," and below that with "blue ground." This superposed yellow on blue is common to all the mines. The blue is the aboriginal ground, and owes its colour chiefly to the presence of lower oxides of iron. When atmospheric influences have access to the iron it becomes peroxidised, and the ground assumes a yellow colour. The thickness of yellow earth in the mines is therefore a measure of the depth of penetration of air and moisture. The colour does not affect the yield of diamonds. The ground mass is soapy to the touch, and friable, especially after exposure to weather. Besides diamonds, more than eighty species of minerals have been recognised in the blue ground, the most common being magnetite, ilmenite, garnet, bright green ferriferous enstatite (bronzite), a hornblendic mineral closely resembling smaragdite, calc-spar, vermiculite, diallage, jeffreysite, mica, kyanite, augite, peridot, iron pyrites, wollastonite, vaalite, zircon, chrome iron, rutile, corundum, apatite, olivine, sahlite, chromite, pseudobrookite, perofskite, biotite, and quartz.

The blue ground does not show any signs of igneous action; the fragments in the breccia are not fused at the edges. The eruptive force was probably steam or water-gas, acting under great pressure but at no high temperature.

There are many such pipes in the immediate neighbourhood of Kimberley. It may be that each volcanic pipe is the vent for its own special laboratory—a laboratory buried at vastly greater depths than we have yet reached —where the temperature is comparable with that of the electric furnace, where the pressure is fiercer than in our puny laboratories and the melting point higher, where no oxygen is present, and where masses of liquid carbon have taken centuries, perhaps thousands of years, to cool to the solidifying point. The chemist arduously manufactures infinitesimal diamonds, valueless as ornamental gems; but nature, with unlimited temperature, inconceivable pressure, and gigantic material, to say nothing of measureless time and appalling energy, produces without stint the dazzling, radiant, beautiful, coveted crystals I am enabled to show you to-night.

This hypothesis of the origin of diamonds is in many ways corroborated.

The ash left after burning a diamond invariably contains iron as its chief constituent; and the most common colours of diamonds, when not perfectly pellucid, show various shades of brown and yellow, from the palest "off colour" to almost black. They are also green, blue, pink, yellow, and orange. These variations give support to the theory advanced by Moissan that the diamond has separated from molten iron—a theory of which I shall say more presently—and also explain how it happens that stones from different mines, and even from different parts of the same mine, differ from each other. Further confirmation is given by the fact that the country round Kimberley is remarkable for its ferruginous character, and iron-saturated soil is popularly regarded as one of the indications of the near presence of diamonds. Along with carbon, molten iron dissolves other bodies which possess

[1] Abridged from a lecture delivered before the British Association at Kimberley on September 5 by Sir William Crookes, F.R.S.

tinctorial powers. One batch of iron might contain an impurity colouring the stones blue, another lot would tend towards the formation of pink stones, another of green, and so on. Cobalt, nickel, chromium, and manganese, all metals present in the blue ground, would produce these colours.

An hypothesis, however, is of little value if it only elucidates half a problem. Let us see how far we can follow out the ferric hypothesis to explain the volcanic pipes. In the first place we must remember these so-called volcanic vents are admittedly not filled with the eruptive rocks, scoriaceous fragments, &c., constituting the ordinary contents of volcanic ducts.

Selections of thin sections of some of these rocks and minerals, mounted as microscopic objects and viewed by polarised light, are not only of interest to the geologist, but are objects of great beauty.

The appearance of shale and fragments of other rocks testifies that the mélange has suffered no great heat in its present condition, and that it has been erupted from great depths by the agency of water vapour or some similar gas. How is this to be explained?

You will recollect I start with the reasonable supposition that at a sufficient depth[1] there were masses of molten iron at great pressure and high temperature, holding carbon in solution, ready to crystallise out on cooling. Far back in time the cooling from above caused cracks in superjacent strata through which water[2] found its way. On reaching the incandescent iron, the water would be converted into gas, and this gas would rapidly disintegrate and erode the channels through which it passed, grooving a passage more and more vertical in the necessity to find the quickest vent to the surface. But steam in the presence of molten or even red-hot iron liberates large volumes of hydrogen gas, together with less quantities of hydrocarbons[3] of all kinds—liquid, gaseous, and solid. Erosion commenced by steam would be continued by the other gases; it would be easy for pipes, large as any found in South Africa, to be scored out in this manner.

Sir Andrew Noble has shown that when the screw stopper of his steel cylinders in which gunpowder explodes under pressure is not absolutely perfect, gas escapes with a rush so overpowering as to score a wide channel in the metal. Some of these stoppers and vents are on the table. To illustrate my argument Sir Andrew Noble has been kind enough to try a special experiment. Through a cylinder of granite is drilled a hole 0·2 inch diameter, the size of a small vent. This is made the stopper of an explosion chamber, in which a quantity of cordite is fired, the gases escaping through the granite vent. The pressure is about 1500 atmospheres, and the whole time of escape is less than half a second. Notice the erosion produced by the escaping gases and by the heat of friction; these forces have scored out a channel more than half an inch diameter and melted the granite along their course. If steel and granite are thus vulnerable at comparatively moderate gaseous pressure, it is easy to imagine the destructive upburst of hydrogen and water-gas grooving for itself a channel in the diabase and quartzite, tearing fragments from resisting rocks, covering the country with débris, and finally, at the subsidence of the great rush, filling the self-made pipe with a water-borne magma in which rocks, minerals, iron oxide, shale, petroleum, and diamonds are violently churned in a veritable witch's cauldron! As the heat abated the water vapour would gradually give place to hot water, which forced through the magma would change some of the mineral fragments into the existing forms of to-day.

Each outbreak would form a dome-shaped hill; the eroding agency of water and ice would plane these eminences until all traces of the original pipes were lost.

Actions such as I have described need not have taken place simultaneously. As there must have been many molten masses of iron with variable contents of carbon, different kinds of colouring matter, solidifying with varying degrees of rapidity, and coming in contact with water at intervals throughout long periods of geological time—so must there have been many outbursts and upheavals, giving rise to pipes containing diamonds. And these diamonds, by sparseness of distribution, crystalline character, difference of tint, purity of colour, varying hardness, brittleness, and state of tension, have the story of their origin impressed upon them, engraved by natural forces—a story which future generations of scientific men may be able to interpret with greater precision than is possible to-day.

Genesis of the Diamond.

Speculations as to the probable origin of the diamond have been greatly forwarded by patient research, and particularly by improved means of obtaining high temperatures, an advance we owe principally to the researches of Prof. Moissan.

Until recent years carbon was considered absolutely non-volatile and infusible; but the enormous temperatures at the disposal of experimentalists—by the introduction of electricity—show that, instead of breaking rules, carbon obeys the same laws that govern other bodies. It volatilises at the ordinary pressure at a temperature of about 3600° C., and passes from the solid to the gaseous state without liquefying. It has been found that other bodies, such as arsenic, which volatilise without liquefying at the ordinary pressure, will easily liquefy if pressure is added to temperature. It naturally follows that if along with the requisite temperature sufficient pressure is applied, liquefaction of carbon will take place, when on cooling it will crystallise. But carbon at high temperatures is a most energetic chemical agent, and if it can get hold of oxygen from the atmosphere or any compound containing it, it will oxidise and fly off in the form of carbonic acid. Heat and pressure, therefore, are of no avail unless the carbon can be kept inert.

It has long been known that iron when melted dissolves carbon, and on cooling liberates it in the form of graphite. Moissan discovered that several other metals, especially silver, have similar properties; but iron is the best solvent for carbon. The quantity of carbon entering into solution increases with the temperature.

For the manufacture of—I am afraid I must say an infinitesimal—diamond, the first necessity is to select pure iron—free from sulphur, silicon, phosphorus, &c.—and to pack it in a carbon crucible with pure charcoal from sugar. The crucible is then put into the body of the electric furnace, and a powerful arc formed close above it between carbon poles, utilising a current of 700 amperes at 40 volts pressure. The iron rapidly melts and saturates itself with carbon. After a few minutes' heating to a temperature above 4000° C.—a temperature at which the iron melts like wax and volatilises in clouds—the current is stopped, and the dazzling fiery crucible is plunged beneath the surface of cold water, where it is held until it sinks below a red heat. As is well known, iron increases in volume at the moment of passing from the liquid to the solid state. The sudden cooling solidifies the outer layer of iron and holds the inner molten mass in a tight grip. The expansion of the inner liquid on solidifying produces an enormous pressure, and under the stress of this pressure the dissolved carbon separates out in transparent forms—minutely microscopic, it is true—all the same veritable diamonds, with crystalline form and appearance, colour, hardness, and action on light the same as the natural gem.

Now commences the tedious part of the process. The metallic ingot is attacked with hot nitro-hydrochloric acid until no more iron is dissolved. The bulky residue consists chiefly of graphite, together with translucent chestnut-coloured flakes of carbon, black opaque carbon of a density of from 3·0 to 3·5, and hard as diamonds—black diamonds or carbonado, in fact—and a small portion of transparent colourless diamonds showing crystalline structure. Besides these, there may be carbide of silicon and corundum, arising from impurities in the materials employed.

The residue is first heated for some hours with strong sulphuric acid at the boiling point, with the cautious addition of powdered nitre. It is then well washed, and for two days allowed to soak in strong hydrofluoric acid

1 A pressure of fifteen tons on the square inch would exist not many miles beneath the surface of the earth.

2 There are abundant signs that a considerable portion of this part of Africa was once under water, and a fresh-water shell has been found in apparently undisturbed blue ground at Kimberley.

3 The water sunk in wells close to the Kimberley mine is sometimes impregnated with paraffin, and Sir H. Roscoe extracted a solid hydrocarbon from the "blue ground."

in cold, then in boiling acid. After this treatment the soft graphite disappears, and most, if not all, the silicon compounds have been destroyed. Hot sulphuric acid is again applied to destroy the fluorides, and the residue, well washed, is attacked with a mixture of the strongest nitric acid and powdered potassium chlorate, kept warm—but not above 60° C., to avoid explosions. This treatment must be repeated six or eight times, when all the hard graphite will gradually be dissolved, and little else left but graphitic oxide, diamond, and the harder carbonado and boart. The residue is fused for an hour in fluorhydrate of fluoride of potassium, then boiled out in water, and again heated in sulphuric acid. The well washed grains which resist this energetic treatment are dried, carefully deposited on a slide, and examined under the microscope. Along with numerous pieces of black diamond are seen transparent colourless pieces, some amorphous, others with a crystalline appearance. Although many fragments of crystals occur, it is remarkable I have never seen a complete crystal. All appear shattered, as if on being liberated from the intense pressure under which they were formed they burst asunder. I have singular evidence of this phenomenon. A fine piece of artificial diamond, carefully mounted by me on a microscopic slide, exploded during the night and covered the slide with fragments. Moissan's crystals of artificial diamond sometimes broke a few weeks after their preparation, and some of the diamonds which cracked weeks or even months after their preparation showed fissures covered with minute cubes. This bursting paroxysm is not unknown at the Kimberley mines.

On the screen I will project photographs of artificial diamonds manufactured in the manner described. So far, these specimens are all microscopic. The largest artificial diamond is less than one millimetre across.

These laboratory diamonds burn in the air before the blowpipe to carbonic acid. In lustre, crystalline form, optical properties, density, and hardness, they are identical with the natural stone.

In several cases Moissan separated ten to fifteen microscopic diamonds from a single ingot. The larger of these are about 0·75 mm. long, the octahedra being 0·2 mm.

Boiling and Melting Point of Carbon.

On the average, the critical point of a substance is 1·5 times its absolute boiling point. Therefore the critical point of carbon should be about 5800° Ab. But the absolute critical temperature divided by the critical pressure is for all the elements so far examined never less than 2·5, this being about the value Sir James Dewar finds for hydrogen. So that, accepting this, we get the maximum critical pressure as follows, viz. 2320 atmospheres:—

$$5800° \text{ Ab./CrP} = 2{\cdot}5, \text{ or CrP} = 5800° \text{ Ab.}/2{\cdot}5, \text{ or } 2320 \text{ atmospheres.}$$

Carbon and arsenic are the only two elements that have a melting point above the boiling point; and among compounds carbonic acid and fluoride of silicium are the only other bodies with similar properties. Now the melting point of arsenic is about 1·2 times its absolute boiling point. With carbonic acid and fluoride of silicium the melting points are about 1·1 times their boiling points. Applying these ratios to carbon, we find that its melting point would be about 4400°.

Therefore, assuming the following data

Boiling point	3870° Ab.
Melting point	4400°
Critical temperature	5800°
Critical pressure	2320 Ats.

the Rankine or Van der Waals formula calculated from the boiling point and critical data would be as follows:—

$$\log. \ P = 10{\cdot}11 - 39120/T,$$

and this gives for a temperature of 4400° Ab. a pressure of 16·6 Ats. as the melting-point pressure. Similar rough estimates obtained by means of this formula suggest that above a temperature of 5800° Ab. no amount of pressure will cause carbon vapour to assume liquid form, whilst at 4400° Ab. a pressure of above 17 atmospheres would suffice to liquefy some of it. Between these extremes the curve of vapour pressure is assumed to be logarithmic, as represented in the accompanying diagram. The constant 39120 which occurs in the logarithmic formula enables us to calculate the latent heat of evaporation. If we assume the vapour density to be normal, or the molecule in vapour as C_2, then the heat of volatilisation of 12 grms. of carbon would be 90,000 calories; or, if the vapour is a condensed molecule like C_6, then the 12 grms. would need 30,000 calories. In the latter case the evaporation of 1 grm. of carbon would require 2500 calories, whereas a substance like zinc needs only about 400 calories.

A New Formation of Diamond.

I have long speculated as to the possibility of obtaining artificially such pressures and temperatures as would fulfil the above conditions. In their researches on the gases from fired gunpowder and cordite, Sir Frederick Abel and Sir Andrew Noble obtained in closed steel cylinders pressures as great as 95 tons to the square inch, and temperatures as high as 4000° C. According to a paper recently communicated to the Royal Society, Sir Andrew Noble, exploding cordite in closed vessels, has obtained a pressure of 8000 atmospheres, or 50 tons per square inch, with a temperature reaching in all probability 5400° Ab.

Here, then, we have conditions favourable for the liquefaction of carbon, and were the time of explosion sufficient to allow the reactions to take place, we should certainly expect to get the liquid carbon to solidify in the crystalline state.[1]

By the kindness of Sir Andrew Noble, I have been enabled to work upon some of the residues obtained in closed vessels after explosions, and I have submitted them to the same treatment that the granulated iron had gone through. After weeks of patient toil I removed the amorphous carbon, the graphite, the silica,[2] and other constituents of the ash of cordite, and obtained a residue among which, under the microscope, crystalline particles could be distinguished. Some of these particles, from their crystalline appearance and double refraction, were silicon carbide; others were probably diamonds. The whole residue was dried and fused at a good red heat in an excess of potassium bifluoride, to which was added during fusion 5 per cent. of nitre. (Previous experiments had shown me that this mixture readily attacked and dissolved silicon carbide; unfortunately it also attacks diamond to a slight degree.) The residue, after thorough washing and then heating in fuming sulphuric acid, was washed, dried, and the largest crystalline particles picked out and mounted. All the operations of washing and acid treatment were performed in a large platinum crucible by decantation (except the preliminary attack with nitric acid and potassium chlorate, when a hard glass vessel was used); the final result was washed into a shallow watch-glass, and the selection made under the microscope.

I project on the screen a few photographs of these crystals. From the treatment they have undergone, chemists will agree with me that diamonds only could stand such an ordeal; on submitting them to skilled crystallographic authorities my opinion is confirmed. Speaking of the one before you (303), Prof. Bonney calls it "a diamond showing octahedral planes with dark boundaries due to high refracting index." After careful examination, Prof. Miers writes of the same crystal diamond:—"I think one may safely say that the position and angles of its faces, *and of its cleavages*, the absence of birefringence, and the high refractive index, are all compatible with the properties of the diamond crystallising in the form of an octahedron. Others of the remaining crystals, which show a similar high refractive index, appeared to me to present the same features."

[1] Sir James Dewar, in a Friday evening discourse at the Royal Institution, 1880, showed an experiment proving that the temperature of the interior of a carbon tube heated by an outside electric arc was higher than that of the oxy-hydrogen flame. He placed a few small crystals of diamond in the carbon tube, and, maintaining a current of hydrogen to prevent oxidation, raised the temperature of the tube in an electric furnace to that of the arc. In a few minutes the diamond was transformed into graphite. At first sight this would seem to show that diamond cannot be formed at temperatures above that of the arc. It is probable, however, for reasons given above, that at exceedingly high pressures the result would be different.

[2] The silica was in the form of spheres, perfectly shaped and transparent, mostly colourless, but among them several of a ruby colour. When 5 per cent. of silica was added to cordite, the residue of the closed vessel explosion contained a much larger quantity of these spheres.

It would have been more conclusive had I been able to get further evidence as to the density and hardness of the crystals; but I am still working at the subject, and hope to add these confirmatory tests. From what I have already said, I think there is no doubt that in these closed vessel explosions we have another method of producing the diamond artificially.

Sensational as is the story of the diamond industry in South Africa, quite another aspect fixes the attention of the chemist. The diamonds come out of the mines, but how did they get in? How were they formed? What is their origin?

Gardner Williams, who knows more about diamonds than any man living, is little inclined to indulge in speculation. In his fascinating book [1] he frankly says :—

"I have been frequently asked, 'What is your theory of the original crystallisation of the diamond?' and the answer has always been, 'I have none; for after seventeen years of thoughtful study, coupled with practical research, I find that it is easier to "drive a coach and four" through most theories that have been propounded than to suggest one which would be based on any non-assailable data.' All that can be said is that in some unknown manner carbon, which existed deep down in the internal regions of the earth, was changed from its black and uninviting appearance to the most beautiful gem which ever saw the light of day."

Meteoric Diamonds.

Another diamond theory appeals to the fancy. It is said the diamond is a gift from Heaven, conveyed to earth in meteoric showers. The suggestion, I believe, was first broached by A. Meydenbauer,[2] who says :—"The diamond can only be of cosmic origin, having fallen as a meteorite at later periods of the earth's formation. The available localities of the diamond contain the residues of not very compact meteoric masses which may, perhaps, have fallen in prehistoric ages, and which have penetrated more or less deeply, according to the more or less resistant character of the surface where they fell. Their remains are crumbling away on exposure to the air and sun, and the rain has long ago washed away all prominent masses. The enclosed diamonds have remained scattered in the river beds, while the fine light matrix has been swept away."

According to this hypothesis, the so-called volcanic pipes are simply holes bored in the solid earth by the impact of monstrous meteors—the larger masses boring the holes, while the smaller masses, disintegrating in their fall, distributed diamonds broadcast. Bizarre as such a theory appears, I am bound to say there are many circumstances which show that the notion of the heavens raining diamonds is not impossible.

The most striking confirmation of the meteoric theory comes from Arizona. Here, on a broad open plain, over an area about five miles in diameter, have been scattered one or two thousand masses of metallic iron, the fragments varying in weight from half a ton to a fraction of an ounce. There is little doubt these masses formed part of a meteoric shower, although no record exists as to when the fall took place. Curiously enough, near the centre, where most of the meteorites have been found, is a crater with raised edges three-quarters of a mile in diameter and about 600 feet deep, bearing exactly the appearance which would be produced had a mighty mass of iron struck the ground and buried itself deep under the surface. Altogether ten tons of this iron have been collected, and specimens of the Canyon Diablo meteorite are in most collectors' cabinets.

An ardent mineralogist—the late Dr. Foote—cutting a section of this meteorite, found the tools were injured by something vastly harder than metallic iron. He examined the specimen chemically, and soon after announced to the scientific world that the Canyon Diablo meteorite contained black and transparent diamonds. This startling discovery was afterwards verified by Profs. Moissan and Friedel, and Moissan, working on 183 kilograms of the Canyon Diablo meteorite, has recently found smooth black diamonds and transparent diamonds in the form of octahedra with rounded edges, together with green hexagonal crystals of carbon silicide. The presence of carbon silicide in the meteorite shows that it must, at some time, have experienced the temperature of the electric furnace. Since this revelation, the search for diamonds in meteorites has occupied the attention of chemists all over the world.

I am enabled to show you photographs of true diamonds I myself have extracted from the Canyon Diablo meteorite. A fine slab of the meteorite, weighing about seven pounds, is on the table before you.

Here, then, we have incontestable proof of the truth of the meteoric theory. Under atmospheric influences the iron would rapidly oxidise and rust away, colouring the adjacent soil with red oxide of iron. The meteoric diamonds would be unaffected, and left on the surface of the soil, to be found haphazard when oxidation had removed the last proof of their celestial origin. That there are still lumps of iron left at Arizona is merely due to the extreme dryness of the climate and the comparatively short time that the iron has been on our planet. We are here witnesses to the course of an event which may have happened in geologic times anywhere on the earth's surface.

Although in Arizona diamonds have fallen from the skies, confounding our senses, this descent of precious stones is what may be called a freak of nature rather than a normal occurrence. To the modern student of science there is no great difference between the composition of our earth and that of extra-terrestrial masses. The mineral peridot is a constant extra-terrestrial visitor, present in most meteorites; and yet no one doubts that peridot is also a true constituent of rocks formed on this earth. The spectroscope reveals that the elementary composition of the stars and the earth is pretty much the same; and the spectroscope also shows that meteorites have as much of earth as of heaven in their composition. Indeed, not only are the self-same elements present in meteorites, but they are combined in the same way to form the same minerals as in the crust of the earth.

It is certain from observations I have made, corroborated by experience gained in the laboratory, that iron at a high temperature and under great pressure—conditions existent at great depths below the surface of the earth—acts as the long-sought solvent for carbon, and will allow it to crystallise out in the form of diamond. But it is also certain, from the evidence afforded by the Arizona and other meteorites, that similar conditions have existed among bodies in space, and that on more than one occasion a meteorite freighted with jewels has fallen as a star from the sky.

Many circumstances point to the conclusion that the diamond of the chemist and the diamond of the mine are strangely akin as to origin. It is evident that the diamond has not been formed *in situ* in the blue ground. The genesis must have taken place at vast depths under enormous pressure. The explosion of large diamonds on coming to the surface shows extreme tension. More diamonds are found in fragments and splinters than in perfect crystals; and it is noteworthy that although these splinters and fragments must be derived from the breaking up of a large crystal, yet in only one instance have pieces been found which could be fitted together, and these occurred at different levels. Does not this fact point to the conclusion that the blue ground is not their true matrix? Nature does not make fragments of crystals. As the edges of the crystals are still sharp and unabraded, the *locus* of formation cannot have been very distant from the present sites. There were probably many sites of crystallisation differing in place and time, or we should not see such distinctive characters in the gems from different mines, nor, indeed, in the diamonds from different parts of the same mine.

It is not difficult to imagine that masses of iron saturated with carbon existed formerly at a sufficient depth below the present mines, where temperature and pressure would produce the reactions which laboratory experiments show to be probable.

Many crystals of diamonds have their surfaces beautifully marked with equilateral triangles, interlaced and of varying sizes. Under the microscope these markings appear as shallow depressions sharply cut out of the surrounding surface; these depressions were supposed by Gustav Rose to indicate the probability that the diamonds at some

[1] "The Diamond Mines of South Africa," p. 510. (Macmillans, 1902.)
[2] *Chemical News*, vol. lxi., p. 209, 1890.

previous time had been exposed to incipient combustion. Rose also noted that striations appeared on the surfaces of diamonds burnt before the blowpipe.

I have tried many times to imitate these markings by partial combustion of clear crystals of diamond, but have not succeeded in reproducing triangles of such beauty as you see formed by nature. According to the crystalline face exposed to incipient combustion the etchings are triangular or cubical, and sometimes intermediate between the two. I throw on the screen magnified photographs of these etchings, and you will observe that while the triangular or box-like tendency is very apparent, there is an absence of regularity and sharpness.

The artificial markings are closer massed, looking as if the diamond during combustion had been dissected into triangular and rectangular flakes, while the markings natural to crystals appear as if produced by the crystallising force as they were being built up.

Certain artificial diamonds present the appearance of an elongated drop. I have seen diamonds which have exactly the appearance of drops of liquid separated in a pasty condition and crystallised on cooling. Diamonds are sometimes found with little appearance of crystallisation, but with rounded forms similar to those which a liquid might assume if kept in the midst of another liquid with which it would not mix. Other drops of liquid carbon retained for sufficient time above their melting point would coalesce with adjacent drops, and on slow cooling would separate in the form of large perfect crystals. Two drops, joining after incipient crystallisation, might assume the not uncommon form of interpenetrating twin crystals. Illustrations of all these caprices are here to-night.

Again, diamond crystals are generally perfect on all sides. They show no irregular side or face by which they were attached to a support, as do artificial crystals of chemical salts; another proof that the diamond must have crystallised from a dense liquid.

Having no double refraction, the diamond should not act on polarised light. But, as is well known, if a transparent body which does not so act is submitted to strain of an irregular character it becomes doubly refracting, and in the polariscope reveals the existence of the strain by brilliant colours arranged in a more or less defined pattern according to the state of tension in which the crystal exists. I have examined many hundred diamond crystals under polarised light, and with few exceptions all show the presence of internal tension. I will project some diamonds on the screen by means of the polarising microscope, and you will see by the colours how great is the strain to which some of them are exposed. On rotating the polariser, the black cross most frequently seen revolves round a particular point in the inside of the crystal; on examining this point with a high power, we sometimes see a slight flaw, more rarely a minute cavity. The cavity is filled with gas at enormous pressure, and the strain is set up in the stone by the effort of the gas to escape. I have already told you that the great Cullinan diamond by this means reveals a state of internal stress and strain.

It is not uncommon for a diamond to explode soon after it reaches the surface; some have been known to burst in the pockets of the miners or when held in the warm hand, and the loss is the greater because large stones are more liable to explode or fly in pieces than small ones. Valuable stones have been destroyed in this way, and it is whispered that cunning dealers are not averse to allowing responsible clients to handle or carry in their warm pockets large crystals fresh from the mine. By way of safeguard against explosion, some dealers imbed large diamonds in raw potato to ensure safe transit to England.

The anomalous action which many diamonds exert on polarised light is not such as can be induced by heat, but it can easily be conferred on diamonds by pressure, showing that the strain has not been produced by sudden cooling, but by sudden lowering of pressure.

The illustration of this peculiarity is not only difficult, but sometimes exceedingly costly—difficult because it is necessary to arrange for projecting on the screen the image of a diamond crystal between the jaws of a hydraulic press, the illuminating light having to pass through delicate optical polarising apparatus—and costly because only perfect, clear crystals can be used, and crystals of this character sometimes fly to pieces as the pressure rises. No colour as yet is seen on the screen, the crystal not being birefringent. A movement of the handle of the press, however, gives the crystal a pinch, instantly responded to by the colours on the screen, showing the production of double refraction. Another movement of the handle brightens the colours; a third may strain the crystal beyond its power of resistance, so I refrain.

Hardness.

Diamonds vary considerably in hardness, and even different parts of the same crystal differ in their resistance to cutting and grinding.

Beautifully white diamonds have been found at Inverel, New South Wales, and from the rich yield of the mine and the white colour of the stones, great things were expected. In the first parcel which came to England the stones were found to be so much harder than South African diamonds that it was at first feared they would be useless except for rock-boring purposes. The difficulty of cutting them disappeared with improved appliances, and they now are highly prized.

The famous Koh-i-noor, when cut into its present form, showed a notable variation in hardness. In cutting one of the facets near a yellow flaw, the crystal became harder and harder the further it was cut, and after working the mill for six hours at the usual speed of 2400 revolutions a minute, little impression was made. The speed was increased to more than 3000, when the work slowly proceeded. Other portions of the stone were found to be comparatively soft, and hardened as the outside was cut away.

I can illustrate the intense hardness of the diamond by experiment. On the flattened apex of a conical block of steel I place a diamond, and upon it I bring down a second cone of steel. With the lamp I project an image of the diamond and steel faces on the screen, and force them together by hydraulic power. I can squeeze the stone into the steel blocks without injuring it in the slightest degree. The pressure gauge shows 60 atmospheres, and the piston being 3·2 inches diameter, the absolute pressure is 3·16 tons, equivalent on a diamond of 12 square mm. surface to 170 tons per square inch of diamond.

Although not directly bearing on the subject, I will introduce the only serious rival of the diamond as regards hardness. It is the metal tantalum, a fine specimen of which I owe to Messrs. Siemens Brothers. A hole had to be bored through a plate of this metal, and a diamond drill was used revolving at the rate of 5000 revolutions per minute. This whirling force was continued ceaselessly for three days and nights, when it was found that only a small depression $\frac{1}{4}$ mm. deep had been drilled, and it was a moot point which had suffered most damage, the diamond or the tantalum.[1] In another respect tantalum is likely to rival graphitic carbon, as it has rivalled adamantine carbon. Its thin wire is extensively used for filaments of incandescent electric lamps; it shows a much higher efficiency than does the old carbon filament. The melting point of tantalum is about 2300° C., a temperature seldom or never reached in an ordinary lamp.

Refractivity.

But it is not the hardness of the diamond so much as its optical qualities that make it so highly prized. It is one of the most refracting substances in nature, and it also has the highest reflecting properties. In the cutting of diamonds advantage is taken of these qualities. When cut as a brilliant the facets on the lower side are inclined so that light falls on them at an angle of 24° 13′, at which angle all the incident light is totally reflected. A well cut brilliant should appear opaque by transmitted light except at a small spot in the middle where the table and culet are opposite. All the light falling on the front of the stone is reflected from the facets, and the light passing into the diamond is reflected from the interior surfaces and refracted into colours when it passes out into the air, giving rise to the lightnings, the effulgence, and coruscations for which the diamond is supreme above all other gems.

In vain I have searched for a liquid of the same refrac-

[1] W. von Bolton *Zeitschr. Elektrochem*, ii., 45–51, January 20, 1905.

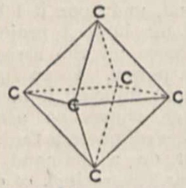
tion as diamond. Such a liquid would be invaluable to the merchant, as on immersing a stone the clear body would absolutely disappear, leaving in all their ugliness the flaws and black specks so frequently seen even in the best stones.

Arguing from theoretical considerations connected with the specific refractive energy of diamond, and employing Lorentz's expression for refraction—

$$\left(\frac{\mu^2-1}{\mu^2+2}\left(\frac{P}{d}\right)\right),$$

in which μ = refractive index, $\mu-1$ = refractive energy, d = density, and P = molecular weight, Brühl has shown that diamond is perfectly normal in its optical properties, and has an atomic refraction = 5. He has put forward the speculation that the diamond may be the last member of the paraffin series of which marsh-gas is the first.

"Now we can imagine," says Brühl,[1] "why the diamond, *i.e.* pure crystallised carbon, is optically normal. We obtain an idea of the mineral's chemical constitution, and of the way in which the atoms of carbon are perhaps combined in the sparkling gem. The diamond cannot possibly contain any double bonds. Imagine, however, at each of the six corners of a regular octahedron, a single molecule of marsh-gas, CH_4, *i.e.* altogether C_6H_{24}, and then imagine all the 24 hydrogen atoms successively removed, so that each carbon atom is connected with each of its neighbours only by a single bond, and thus all six atoms of carbon are united together in a single whole. Then you obtain, as the most simple representation of the molecule of the diamond, a regular octahedron, with one atom of carbon at each of its six corners, whilst the edges represent the mutual bonds :—



Several simple molecules of this kind may be combined into one crystallised particle of the spectrochemically normal diamond."

Absorption Spectrum of Diamond.

On passing a ray of light through a diamond and examining it in a spectroscope, B. Walter has found in all colourless brilliants of more than one carat in weight an absorption band at wave-length 4155 (violet). He ascribes this band to an impurity, and suggests it may possibly be due to samarium. Three other fainter lines were detected in the ultra-violet by means of photography.

Phosphorescence of Diamond.

After exposure for some time to the sun many diamonds glow in a dark room. Some diamonds are fluorescent, appearing milky in sunlight. In a vacuum, exposed to a high-tension current of electricity, diamonds phosphoresce of different colours, most South African diamonds shining with a bluish light. Diamonds from other localities emit bright blue, apricot, pale blue, red, yellowish green, orange, and pale green light. The most phosphorescent diamonds are those which are fluorescent in the sun. One beautiful green diamond in my collection, when phosphorescing in a good vacuum, gives almost as much light as a candle, and you can easily read by its rays. But the time has hardly come when diamonds can be used as domestic illuminants! The emitted light is pale green, tending to white, and in its spectrum, when strong, can be seen bright lines, one at about λ 5370 in the green, one at λ 5130 in the greenish blue, and one at λ 5030 in the blue.

After many years' bombardment in a vacuum tube this diamond grew very dark, almost black, on the surface. Heating in a mixture of nitric acid and potassium chlorate scarcely changed the colour. The action of heat was then tried, and on slowly heating to about 500° C. the dark colour entirely disappeared, and the original milky green appearance was restored. Although I watched narrowly I could see no trace of phosphorescence during the heating.

Diamonds which phosphoresce red generally show the yellow sodium line superposing on a continuous spectrum. In one Brazilian diamond phosphorescing a reddish yellow colour, I detected the citron line characteristic of yttrium.

By permission of Mrs. Kunz, wife of the well known New York mineralogist, I will show you perhaps the most remarkable of all phosphorescing diamonds. This prodigy diamond will phosphoresce in the dark for some minutes after being exposed to a small pocket electric light, and if rubbed on a piece of cloth a long streak of phosphorescence appears.

Tribo-luminescence.

A few minerals give out light when rubbed, and Mrs. Kunz's diamond is equally striking in this respect. In the year 1663, the Hon. Robert Boyle read a paper before the Royal Society, in which he described several experiments made with a diamond which markedly showed tribo-luminescence. As specimens of tribo-luminescent bodies, I show you sphalerite (sulphide of zinc) and an artificial sphalerite, which is even more responsive to friction than the native sulphide.[1]

Combustion of the Diamond.

When heated in air or oxygen to a temperature varying from 760° C. to 875° C., according to its hardness, the diamond burns with production of carbonic acid. It leaves an extremely light ash, sometimes retaining the shape of the crystal, consisting of iron, lime, magnesia, silica, and titanium. In boart and carbonado the amount of ash sometimes rises to 4 per cent., but in clear crystallised diamonds it is seldom higher than 0·05 per cent. By far the largest constituent of the ash is iron.

Action of Radium on Diamond.

The β rays from radium having like properties to the stream of negative electrons in a radiant matter tube, it was of interest to ascertain if they would exert a like difference on diamond. The diamond glows under the influence of the β radiations, and crushed diamond cemented to a piece of card or metal makes an excellent screen in a spinthariscope—almost as good as zinc sulphide. Some fine colourless crystals of diamond were embedded in radium bromide and kept undisturbed for more than twelve months. At the end of that time they were examined. The radium had caused them to assume a beautiful blue colour, and their value as "fancy stones" had been materially increased. Here are a couple of diamonds originally of the same purity of water. One has been coloured by radium, the other is in its natural state. The colour of the radium-tinted stone is very pronounced. The lantern slide shows the darkening thus produced. A and B are diamonds after twelve months' burial in radium bromide; diamond C is of the original colour.

This blue colour is persistent, and penetrates below the surface. It is unaffected by long-continued heating in strong nitric acid and potassium chlorate, and is not discharged by heating to redness.

To find out if this prolonged contact with radium had communicated to the diamond any radio-active properties, six diamonds were put on a photographic plate, and kept in the dark for a few hours. I will project the image of the result after development. The three on the upper row are the diamonds which have had a prolonged sojourn with radium, the three below are similar diamonds picked out for comparison, which have not been near radium. See how strangely the three upper ones have acted. Notice also that by mere contiguity to the others the lower diamonds also shine with an induced, factitious radio-activity. I throw on the screen a magnified image of one of the blue crystals, and you see in how regular and geometrical a pattern the radio-active emanations radiate from the crystal. This observation has only been made

[1] *Proceedings of the Royal Institution*, May 26, 1905.

[1] Artificial tribo-luminescent sphalerite :—

Zinc carbonate	... ...	100 parts
Flower of sulphur	... ...	30 ,,
Manganese sulphate	... ...	½ per cent.

Mix with distilled water and dry at a gentle heat. Put in luted crucible and keep at a bright red heat for from two to three hours.

a short time, and is still under investigation. Like the blue tint, the radio-activity persists after drastic treatment. To me this proves that radio-activity does not merely consist in the adhesion of electrons or emanations given off by radium, to the surface of an adjacent body, but the property is one involving layers below the surface, and like the alteration of tint is probably closely connected with the intense molecular excitement the stone had experienced during its twelve months' burial in radium bromide.

A diamond that had been coloured blue by radium, and had acquired strong radio-active properties, was slowly heated to dull redness in a dark room. Just before visibility a faint phosphorescence spread over the stone. On cooling and examining the diamond, it was found that neither the colour nor the radio-activity had suffered appreciably.

The diamond is remarkable in another respect. It is extremely transparent to the Röntgen rays, whereas highly refracting glass, used in imitation diamonds, is almost perfectly opaque to the rays. I exposed for a few seconds over a photographic plate to the X-rays the large Delhi diamond of a rose-pink colour weighing 31½ carats, a black diamond weighing 23 carats, and a glass imitation of the pink diamond. On development, the impression where the diamond obscured the rays was found to be strong, showing that most rays passed through, while the glass was practically opaque. By this means imitation diamonds can readily be distinguished from true gems.

I have already signified that there are various degrees of refractoriness to chemical reagents among the different forms of graphite. Some dissolve in strong nitric acid; other forms of graphite require a mixture of highly concentrated nitric acid and potassium chlorate to attack them, and even with this intensely powerful agent some graphites resist longer than others. M. Moissan has shown that the power of resistance to nitric acid and potassium chlorate is in proportion to the temperature at which the graphite was formed, and with tolerable certainty we can estimate this temperature by the resistance of the specimen of graphite to this reagent.

The superficial dark coating on a diamond after exposure to molecular bombardment I have proved to be graphite.[1] M. Moissan[2] has shown that this graphite, on account of its great resistance to oxidising reagents, cannot have been formed at a lower temperature than 3600° C.

It is thus manifest that the bombarding electrons endowed with an electric charge, and striking the diamond with enormous velocity, raise the superficial layer to the temperature of the electric arc, and turn it into graphite, whilst the mass of diamond and its conductivity to heat are sufficient to keep down the general temperature to such a point that the tube appears scarcely more than warm to the touch.

A similar action occurs with silver, the superficial layers of which can be raised to a red heat without the whole mass becoming more than warm.[3]

I will now direct your attention to a strange property of the diamond, which at first sight might seem to discount the great permanence and unalterability of this stone. It has been ascertained that the cause of phosphorescence is in some way connected with the hammering of the electrons, violently driven from the negative pole, on to the surface of the body under examination, and so great is the energy of the bombardment that impinging on a piece of platinum or even iridium the metal will actually melt. When the diamond is thus bombarded in a radiant matter tube the result is startling. It not only phosphoresces, but assumes a brown colour, and when the action is long-continued becomes almost black.

I will project a diamond on the screen and bombard it with radiant matter before your eyes. I do not like to anticipate a failure, but I am at the mercy of my diamond. I cannot rehearse this experiment, and it may happen that the diamond I have selected will show caprice and not blacken in reasonable time. Some diamonds visibly darken in a few minutes, while others, more leisurely in their ways, require an hour.

This blackening is only superficial, but no ordinary means of cleaning will remove the discoloration. Ordinary oxidising reagents have little or no effect in restoring the colour. The black stain on the diamond is due to a form of graphite which is resistant to oxidation.

Conversion of Diamond into Graphite.

Although we cannot convert graphite into diamond, we can change the diamond into graphite. I take a clear crystal of diamond and place it between two carbon poles, and throw the image on the screen by means of a powerful arc lamp behind. I now bring the poles with intervening diamond together and form an arc between. The temperature of the diamond rapidly rises, and when it approaches 3600° C., the vaporising point of carbon, it breaks down, swells, and changes into black and valueless graphite. I show this experiment because it is striking and suggestive. I may add that it is costly—because the stone, if not of fine quality, might easily burst.

[1] *Chemical News*, vol. lxxiv., p. 39, July, 1896.
[2] *Comptes rendus*, cxxiv., p. 653.
[3] *Proc. Roy. Soc.*, vol. l., p. 99, June, 1891.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SIR CLEMENTS R. MARKHAM, K.C.B., F.R.S., will deliver an address at Cambridge on Thursday, October 19, introductory to the courses of instruction in geography.

Science announces the death of General Isaac J. Wistar, of Philadelphia, founder of the Wistar Institute of Anatomy and Biology of the University of Pennsylvania, formerly president of the American Philosophical Society. By his will the Wistar Institute will receive the residue of his estate, thought to amount to about 80,000*l*.

IN the course of an address to the students of Cornell University in 1903, President Schurman emphasised the necessity of a systematic distribution of the daily time of college students. He recommended the following general apportionment of hours:—for work, eleven; for sleep, eight; for amusement, one; for meals and athletics, two hours each. Work is made to include not only time spent in the laboratory and lecture-room and in private study, but also time given to societies and to self-support. This advice led Dr. Guy M. Whipple, of Cornell University, to try to ascertain how the students in his university actually do distribute their daily time. The results of his inquiries are described in an article in the current number of the *Popular Science Monthly*. In the summary to the detailed tables given in his article Dr. Whipple states that, taking the university as a whole, the average Cornell student devotes just nine hours daily to college work, sleeps 7·9 hours, devotes 2·23 hours to amusement, 1·72 hours to physical exercise, 1·4 hours to meals, 0·39 hour to self-support, and 1·36 hours to unclassified activities. The average length of time given to work is greatest in the college of medicine, and progressively less in those of engineering, law, agriculture, and arts. Both in the university at large and within the College of Arts and Sciences, men give more time to college work than women.

PROF. J. W. JUDD, F.R.S., distributed on October 5 the medals and prizes gained during the past session by the students of the Royal College of Science, London, in the lecture theatre of the Victoria and Albert Museum, South Kensington. The Dean, Prof. Tilden, F.R.S., in opening the proceedings, referred with regret to several losses which the college and school had sustained during the year, alluding particularly to the death of Prof. Howes. The geological division had lost its chief by the retirement of Prof. Judd. The college is now, the Dean continued, in an attitude of expectancy in regard to the future, and it is possible that next year they will be able to hold the prize distribution in the new buildings. He said that in ten years seventy-six of the students of the college have taken the degree of B.Sc., and, in addition, thirty have taken first-class honours, besides which there are nine doctors of science. Prof. Judd, having distributed the awards, addressed the students. He acknowledged the uniform courtesy and consideration which he had received from colleagues and students alike during his forty-five years' experience in connection with the school. Nearly two-thirds of that period had been spent in the position of one of the teachers. He congratulated them on the expansion and development which is now promised, and expressed the hope that the change would lead to even greater successes in the future than have been attained in the past. Mr. R. L. Morant, permanent secretary of the Board of Education, in moving a vote of thanks to Prof. Judd, said the college stood for the essential necessity of practical work as a proper means of the study of science.

THE new College of Hygiene and Physical Training instituted by the Carnegie Dunfermline trustees, which was described in our issue for September 28 (p. 550), was opened formally on October 4 by Lord Linlithgow, Secretary for Scotland and vice-president of the Council of Education in Scotland. The chairman, Dr. John Ross, delivered the opening address. He said the work of the college is to be two-fold. Following the method established for the training of the teachers in elementary schools, there is provided first what may be called a great practising school with 4500 pupils, consisting of all the school children, and next there is the college proper, consisting of young women prepared to adopt the teaching of physical culture as a profession, or to acquire for their own personal benefit a knowledge of themselves and the most rational rules of life. As yet only young women are to be received, but it is anticipated that it will be possible in the near future to receive young men. Lord Linlithgow, during the course of an interesting speech, said there is no doubt that the country is waking up to the necessity of some sort of physical training for young people, and to the necessity of a better understanding of the laws of hygiene. It is well that the public should understand what physical training means. Lord Linlithgow defined it as the careful development of the general health to the advantage of the whole body, and indirectly to the advantage of the mind. The Carnegie trustees are, he continued, doing a great and valuable service to Scotland in taking up this subject. They are doing a work which no school board can do, for it is doubtful whether public opinion has as yet ripened sufficiently to allow the Education Department to apply any considerable portion of the national funds to a purpose of this kind. It will come in time, for the public is taking an increasing interest in all that concerns the feeding, the management, the cleanliness, and physical welfare of the young generation. It is being recognised more and more that the amount of information, or book-learning, which a child acquires at school is a matter of comparatively little importance. What is wanted is the healthy training of the boy or girl both physically and mentally.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, July 14.—"The Phagocytosis of Red Blood-cells." By Dr. J. O. Wakelin **Barratt.** Communicated by Sir Victor Horsley, F.R.S.

The author has investigated the conditions under which phagocytosis of red blood-cells, by means of leucocytes, is brought about. Metchnikoff, who studied this process, attached great importance to the part played by the leucocytes, but Sawtchenko discovered that the chief factor in the production of this form of phagocytosis is sensibilisation of the red blood-cells, which can be brought about by the serum of animals which have been previously injected with the variety of red blood-cells employed for phagocytosis, and he attributed the action of the serum to the presence of amboceptor (immunisine, fixateur). That this is not so, however, is shown by the circumstance that, in the absence of amboceptor, strongly marked phagocytosis may be brought about by serum, and further experiments showed that the effective constituent is an opsonin. In addition, it was found that erythrocytic opsonins are sometimes present, usually in relatively small quantities, in normal sera, and in suitably chosen conditions of experiment may be used to prepare red blood-cells for ingestion by leucocytes.

PARIS.

Academy of Sciences, October 2.—M. Troost in the chair.—Summary of the observations of the solar eclipse of August 29–30 made at Sfax, Tunis: G. **Bigourdan.** Light clouds were present during the eclipse, but were not sufficiently numerous to interfere seriously with the observations. Particulars are given of the determination of time, the observations of the contacts, the photography of the inner corona, the monochromatic photography of the corona, the work done with the spectrographs, ocular and photographic photometry, the influence of the passage of the shadow on the magnetic state of the earth, meteorology and actinometry, drawings made with the naked eye, observation of the moving shadows, the darkness during the eclipse, and the visibility of the stars.—On the laws of sliding friction: Paul **Painlevé.** An extension of the results obtained in a previous paper and a reply to some objections.—Observation of the eclipse of the sun of August 30 at the Observatory of Marseilles: M. **Stéphan.** The atmospheric conditions were quite satisfactory. The times of first and second contact are given, and the changes of temperature were automatically registered.—On some differential equations of the second order: Richard **Fuchs.**—On minimum surfaces: S. **Bernstein.**—Experimental verifications of the undulatory form of the photographic function: Adrien **Guébhard.**—On isostrychnine: A. **Bacovesco.** Isostrychnine is obtained by heating strychnine with water in sealed tubes at 160° C. to 180° C. The colour reactions of the isomer resemble those of the original alkaloid, but there are points of difference. The poisonous properties of the isomer are less marked than in strychnine, and, indeed, rather approximate to those of curare. That the two alkaloids are structurally different is shown by the action of sodium ethylate, which converts isostrychnine integrally into the isostrychnic acid of Tafel. —On the mode of propagation of some aquatic plants: Louis **François.**—On the geology of the Sahara: R. **Chudeau.**—On the direction of the permanent magnetisation of a metamorphic clay from Pontfarlin (Cantal): Bernard **Brunhes.**

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