THURSDAY, JUNE 7, 1900.

MODERN PHYSICAL CHEMISTRY.

The Theory of Electrolytic Dissociation. By H. C. Jones. Pp. xii + 289. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.)

THE theory of electrolytic dissociation is only some fifteen years old, but in that short time its growth has been very great, and its suggestiveness most marked. We gladly welcome a volume on the subject by one who has himself done much to promote its advance, and to render more secure some of the positions it has taken.

The author's preface explains his object; he has been asked from time to time where an account of the newer developments of physical chemistry is to be found. Original memoirs are not always accessible to a student, and in many cases explanation is wanted, and further development of an argument or line of thought may prove helpful; and so Mr. Jones has given us a book based in the main directly on the work of van 't Hoff, Ostwald, Arrhenius and the others who have made the theory, but in which the numerous developments of Arrhenius' original idea are skilfully brought together, and the bearing of the theory on phenomena, apparently widely diverse, is clearly shown. The plan of the book is in the main a good one. The first chapter is devoted to the earlier physical chemistry with the object of showing its relation to that which was to follow; accounts are given of Kopp's work on the boiling points of liquids and on molecular volumes, of the researches of Lorentz, Gladstone and Dale, Le Bel and van 't Hoff and Perkin on optical properties. The investigations of Favre and Silbermann, Berthelot and Julius Thomsen into thermal chemistry, the electrolytic work of Faraday and Clausius, Hittorf and Kohlrausch, are described; and an interesting and important discussion of the development of chemical dynamics and chemical statics concludes the chapter.

In the explanation of Guldberg and Waages' Law of Mass Action, there is a vague and somewhat unsatisfactory use of the word *force;* we are told that

"if we represent the active masses of two substances by m and n, and the coefficient depending on the nature of the substance, &c., by c, the force of the chemical reaction is expressed by mnc."

"Force" has no meaning used in this connection, the mass of compounds, or the number of molecules of compounds produced, can clearly be put equal to mnc, and the condition of equilibrium will be reached when this mass is equal to the mass of matter combining to form the original substance. There is an obvious misprint on page 62; k'/k is clearly written for c'/c of page 61.

In Chapter ii. we are introduced to the main subject of the book. An account is given of van 't Hoff's original paper "The Rôle of Osmotic Pressure in the Analogy between Solutions and Gases" (*Zeitschrift für physikalische Chemie*, i. p. 481), and the grounds for believing that in certain solutions the osmotic pressure conforms exactly to the three gaseous laws of Boyle, Gay Lussac and Avogadro are stated. Attention is here drawn to the large class of compounds, all the acids, all the bases, and all the salts, which form exceptions to the above statement. For these the law is no longer $PV = RT$, but $PV = iRT$, where i is a coefficient always greater than unity, to which a meaning is given when we consider the work of Arrhenius.

According to this the molecules in an electrolyte, or some of them, are dissociated into ions. The electrolytic effects depend on the dissociated or active molecules; let these be n in number, and suppose each is divided into k parts; suppose also that there are m molecules remaining inactive or undissociated, then the total number of molecules is $m + n$, the number of inactive molecules and ions is $m + kn$, and the value of van 't Hoff's coefficient i is shown to be $(m + kn)/(m + n)$.

Arrhenius' theory of electrolysis is an extension of that of Clausius. Clausius had shown that in an electrolyte it was necessary to suppose some molecules of the dissolved salt were broken up into ions; Arrhenius explained how to determine from observations on osmotic pressure the number of such molecules in a given solution.

From this we are led on to two interesting chapters—"Evidence for the Theory" and "Applications of the Theory"; the evidence which the author has accumulated is most valuable, while the fertility and resourcefulness of the theory are strikingly shown. The book will be very useful; at the same time, in one respect, it is open to criticism of some importance. A student not unnaturally asks, What is osmotic pressure due to? Why, under certain circumstances, does liquid run into a closed vessel apparently against the pressure? What is the mechanism by which such a process is managed? It may be answered, We do not know! The author may fairly wish to use language independent of any molecular theory, and not bind himself down in any way; it is enough for many purposes, it may be said, to know that there is a definite pressure in such a solution without inquiring how that pressure is caused. At the same time it is impossible to avoid alluding to molecular impacts and the like; there is no evidence that Mr. Jones does wish to avoid it, and in places, *e.g.* p. 95 and elsewhere, he refers to the modern kinetic theory of gases, and we think—this is the criticism—that it would have made the book clearer if he had based his explanation throughout on the extension of that theory to liquids. When an ordinary experiment for measuring osmotic pressure is started with a solution inside a vessel closed with a semi-permeable membrane, the number of water molecules which strike a unit of area of the interior surface in any given time is less than the number striking the same area on the outside; thus more molecules of water enter the space than leave it; the molecules of the salt cannot pass the membrane, hence the pressure inside increases. The tendency is both for the water and the dissolved substance to distribute themselves uniformly; the pressure inside is due to the impacts (1) of the water, (2) of the dissolved substance that outside arises from the impacts of the water only; ultimately the pressures due to the water balance, and the excess of pressure inside measures the effect due to the impacts of the dissolved substance.

The whole is merely an example of the first proposition of Mr. Jones' third chapter. The physical properties of completely dissociated substances should be additive. This is all implied in the book; it might with advantage be stated more precisely.

 G

Another matter with regard to which a greater definiteness seems desirable, even at the expense of some generality, is the theory of the action of the voltaic cell.

Nernst's theory of the electrolytic "solution-tension" of a solid—solution-pressure is a preferable term—is stated in his own words, but they are vague:

"We must ascribe," it is said, after a reference to osmotic pressure, "to a dissolving substance in contact with a solvent, similarly, a power of expansion, for here also the molecules are driven into a space in which they exist under a certain pressure. It is evident that every substance will pass into solution until the osmotic partial pressure of the molecules in the solution is equal to the 'solution-tension' of the substance" (pp. 231–232).

We may put the whole theory slightly differently, thus:—

In the case when a substance is being dissolved in such a way that *molecules* pass from the solid into the liquid, the pressure rises in consequence of the impacts of these molecules on the walls of the containing vessel; now when molecules also pass from the liquid into the solid, the "evident" fact is that the steady state is reached when the numbers entering and leaving the liquid are the same. In such a case the osmotic pressure measures the solution-pressure, and no electrical action is involved.

But now let us suppose that a metal is passing, not in the form of *molecules*, but in that of *ions* into water. Each of these ions carries with it a positive charge; the water therefore tends to become positive, the metal negative, and an electrical double layer is formed over the surface of separation. The charged ions are not free to move throughout the water, but few escape from the surface; hence the additional pressure due to the impacts of the metallic ions—the solution-pressure, as it is called—is small.

Again, let us take the case of a metal, such as copper, in a solution of one of its own salts, say copper sulphate; here, also, if there were no electrical effects, we might suppose that copper *molecules* would be deposited out of the sulphate on to the metal, while other molecules would leave the metal; the steady state would be reached when these two sets of molecules became equal in number, and the osmotic pressure would become—in reality, unless the solution were very weak, would *fall* to—the solution pressure. But according to the theory, the copper passes as *ions* which carry with them out of the solution their positive charge; this they give up to the metal on becoming molecules. And since we suppose that, unless the solution be very weak, the number of copper ions leaving it is, to start with, greater than those entering, the metal becomes positive, the negative ions of the solution are attracted to it, the positive ions driven off, a double layer is again formed; a difference of electrical potential is established between the metal and the solution—the metal being positive, the solution negative.

If, however, we consider a metal, such as zinc, which has a high solution pressure when immersed in, say, zinc sulphate, we must suppose that at the start more metallic ions leave the metal than enter it, the solution thus becomes positive, the metal negative, and the double layer formed is one which tends to prevent the positive metallic ions from leaving the zinc, and is thus opposite to that formed on the copper.

In both these cases we must suppose, when the steady state is reached, that the ions leaving the metal leave it under the solution pressure of the metal in the liquid. This may be seen as follows: If there were no electrical force called into action, the pressure would go on changing in the liquid up to the solution pressure, when the number of metallic ions leaving the surface would balance those entering.

Thus the solution pressure measures the whole amount of momentum which the ions of the metal tend to transfer per second across unit area of the surface. Now according to the theory this momentum depends on the metal only, and the tendency to transfer momentum remains the same, however the transfer be stopped; in reality, the electrical forces acting across the double layer stop it, not the opposing momentum of the liquid ions, and the pressure exerted by these electrical forces must be therefore equal to the solution pressure of the solid, *i.e.* when a current is flowing the positive ions start from the metal at the solution pressure of the metal, and become, when in the solution, ions at the osmotic pressure of the liquid.

Now, however, let us suppose that a piece of copper is connected to the zinc, the two being dipped into zinc sulphate; and suppose further, for simplicity, that there is no action at the interfaces zinc-copper or copper-liquid, then negative electricity from the zinc passes over to the copper through the zinc-copper junction, attracting to itself the positive ions in the solution and destroying the double layer at the zinc-liquid junction; thus a current of positive electricity passes through the solution from zinc to copper. The source of the E.M.F. is at the zinc-liquid junction, arising from the fact that more zinc ions pass from the zinc into the solution than from the solution into the zinc; or, as Nernst would put it, that the solution pressure of the zinc is greater than the osmotic pressure of the liquid. In reality, of course, there may be actions at both the other junctions similar in character to that which we have supposed to go on at the junction of the zinc and the liquid, and the resultant E.M.F. depends on all of these.[1]

In this simple case the energy of the cell is obtained from the passing of the zinc ions from the saturation pressure of the zinc to the osmotic pressure of the liquid, and we obtain at once Nernst's expression for the electromotive force, varying as $RT \log_e P/p$, where P is the saturation pressure, p the osmotic pressure.

But an article which started as a notice of Mr. Jones' most useful book is in danger of becoming a dissertation on the seat of the electromotive force of a voltaic cell, a result to be avoided. R. T. G.

MESOZOA AND ENANTIOZOA.

Traité de Zoologie Concrète. T. ii. 1^re^ partie. *Mésozoaires—Spongiaires.* By Yves Delage and Edgard Hérouard. Pp. ix + 244. (Paris: C. Reinwald, 1899.)

AS might have been anticipated, this part of the massive "Traité de Zoologie," which is now in course of publication, contains matter of exceptional interest. One-fifth of the present issue is devoted to the Mesozoa,

1 A reference should be made to Prof. Lodge's article in the May number of the *Philosophical Magazine*, which has appeared since the above wa written.

and the remainder to the Sponges. The Mesozoa are classified provisionally under four divisions:—(1) Mesocœlia for *Salinella*; (2) Mesenchymia for *Trichoplax* and *Treptoplax*; (3) Mesogonia for *Dicyemidae* (parasitic in the renal sacs of dibranchiate Cephalopods) and *Orthonectidae* (parasites of Nemertines, Ophiurids and Polychaets); (4) Mesogastria for *Pemmatodiscus*.

Salinella has been regarded as the incarnation of an ideal promorph, the true *Mesozoon*, or link between unicellular and multicellular animals. The minute creature which has been saddled with so grave a responsibility was found, in 1892, by the late Dr. Frenzel in a jar of 2 per cent. salt solution containing mud taken from the salt works of Cordoba, in the Argentine Republic. The jar had been exposed for a long time, and some iodine washings had been thrown into it by mistake. The authors of the "Traité" give a full account of *Salinella*, and admit that, if it really exists, "c'est le vrai Mésozoaire."

When the complex character of the structure and life-history of the higher Protozoa is considered, the imputed simplicity of *Salinella* becomes almost grotesque, and it seems impossible to assign a cosmic importance to it, even should its autonomy become, in future years, an established fact.

"On ne le dit pas, mais il règne une certaine méfiance vis-à-vis de cet être venu si à propos, recueilli dans des conditions si étranges, observé si loin de nous et une seule fois. Ce vase contenant un liquide artificiel, exposé à l'air et aux poussières, qui a reçu les rinçures de la verrerie d'une table d'histologiste, ce pays lointain, tout cela ne prouve rien d'une manière positive contre la Salinelle."

Trichoplax and *Treptoplax* are likewise aquarium-products, the former having been found at Trieste, in 1883, by Prof. F. E. Schulze, and the latter at Naples, in 1892, by Prof. F. S. Monticelli. These forms, which superficially resemble an acœlous Turbellarian, are riddles of the aquarium, like *Salinella* in this respect, and it seems premature to draw far-reaching conclusions from them until they are themselves solved.

The authors of the "Traité" introduce new matter into their account of the Mesogonia derived from a work written in Russian by N. A. Keppen, in which the spermatozoa of *Dicyema* are described and figured for the first time. Attention is drawn to the mystery surrounding the dissemination of the Dicyemid parasites from one host to another, since it is only the infusoriform males which can endure immersion in sea-water, this being quickly fatal to the vermiform females.

Pemmatodiscus is a gastruliform organism found by Monticelli (1895), living in closed sacs in the jelly of a Medusa, *Rhizostoma pulmo*. It would no doubt have excited enthusiasm twenty years ago. Its right to be regarded as an independent type is founded upon three considerations, namely, its parasitic habit, its inability to endure immersion in sea-water, and its power of multiplying by division. The first and last of these reasons are by no means conclusive, since parasitic larvæ, as well as embryos contained in brood-pouches, are known among Medusæ, as is also the phenomenon of embryonic fission.

An account of Haeckel's Gastræadæ is given on pp. 38 and 39, by way of appendix. One might almost have expected to find that the apocryphal Physemaria would have been allowed to go the way of *Bathybius* and *Eozoon*.

A second appendix (pp. 40-45) is devoted to the ciliated urns found in the body-cavity of Sipunculids. These are regarded by M. M. Kunstler and Gruvel, whose original drawings are here published for the first time, as being certainly parasites, and not forming part of the organisation of the Sipunculid. Two genera are described, *Kunstleria* n.g. from *Phymosoma*; and *Pompholyxia*, Fabre-Domergue, from *Sipunculus*.

In their treatment of the Sponges, the authors tread on firmer ground, and the result of their labours is a most satisfactory performance. As promorph (type morphologique) of the entire group, they select for preliminary description the *Olynthus* of Haeckel. *Olynthus* is a generalised abstraction which has its embodiment in concrete zoology. Admitting that a treatise on Sponges at present could hardly be introduced in any other way, it may be pointed out that there are reasons for doubting whether the phyletic value of the *Olynthus* is as great as its undoubted morphological and didactic importance.

In the section devoted to the calcareous sponges (pp. 66-82), the authors quote freely from the researches of our compatriots, Prof. E. A. Minchin and Mr. G. P. Bidder. The classification recently suggested by Bidder is given *in extenso* on p. 67, although not adopted in the body of the work.

The sextets of actinoblasts which secrete the triradiate spicules of Ascons, as discovered and described by Minchin, are duly recorded, but the figure reproduced on p. 67 gives no idea of the excellence of the illustrations contained in Minchin's monograph.

The complete inversion of the layers, which takes place at the metamorphosis (pp. 60, 69, 106, 159), marks one of the most interesting phases of sponge-life. The primitive endoderm of the larva gives rise to the permanent epidermis of the adult, while the primitive flagellated ectoderm sinks in to form the flagellated chambers of the adult. This fact of inversion has induced Delage to separate the Sponges, under the designation Enantiozoa, from all other Metazoa.

The metamorphosis of the parenchymula-larva is accompanied by phenomena which have an interest extending beyond the limits of sponge-lore. The account given on pp. 110-111 shows the following succession of events which occurs in some cases during the conversion of the flagellated ectoderm of the larva into the choanocytes (collar-cells) of the adult:—

I.	II.	III.	IV.
Flagellated Ectoderm.	Histolysed Ectoderm.	Syncytial Ectoderm.	Choanocytes.

The reconstructions on the coloured plates, which elucidate the increasing complexity of the inhalent and exhalent canal systems throughout the group, are well executed, and produce a satisfying impression of solidity and reality. If there is a complaint to be made, it is that, in not a few cases, the authors have omitted to add in brackets the name of the generic type to which the diagrams and text-figures may be taken to refer.

Textual errors and inconsistencies are rare, and obvious when they occur. A few examples will suffice. On pp. 2 and 36, the terms "cœlomique" and "cœlome" refer to a blastocœlic space; on p. 60, "gemmules" is given as an alternative expression to "bourgeons," which arise as outgrowths involving all the layers of the body (*e.g. Lophocalyx*), whereas on p. 177 the endogenous "gemmules" of *Spongilla* are rightly described as special formations, quite distinct from ordinary lateral or exogenous buds, although the buds of *Tethya* (p. 167) seem to be intermediate between the exogenous and endogenous varieties. On p. 91 (footnote), Sollas's term *collenchyme* is branded, with other related terms, as "bien inutile," but on p. 152 the superficial cortex of *Geodia* is characterised as "collenchymateuse."

In a footnote on page 203, we are reminded that H. J. Carter instituted a comparison between the flagellated chambers of sponges and the branchial sac of Ascidians. The authors add that this comparison "nous semble bien singulière aujourd'hui où ces êtres sont mieux connus." On the contrary, the comparison is appropriate, the analogy between the flagellated chambers of a sponge (in respect of their respiratory and nutritive functions and of their relations to the inhalent and exhalent canals) and the branchial sacs of the Ascidiozooids in a compound Tunicary (*cf.* especially the Didemnidæ) being an extraordinarily close one; but of course Carter was innocent of the distinction between homology and homoplasy. What is very singular indeed is the fact that, in these latter days, the same fatal confusion between actual physiological conditions and abstract genetic relationships is constantly being repeated. A. W.

THE DURATION OF THE BRITISH COAL-FIELDS.

Les Charbons Britanniques et leur épuisement. By E. Lozé. Pp. ix + 559, and vii + 562 to 1229. (Paris: C. Béranger, 1900.)

IN France, as in the rest of Europe, consumers have during the past winter been complaining of the difficulty of obtaining an adequate supply of coal, the chief cause of the increased demand having been the activity in the iron and steel trades. At the same time, prolonged strikes in Austria and elsewhere, and the temporary cessation of the production of the collieries of Natal and Cape Colony, have lessened the supplies usually available. The prevailing scarcity of coal is a matter of serious moment to France, where, owing to the increasing depth of the collieries and the costly nature of mining operations, the quantity of coal that has to be imported from other countries grows larger every year. At the present time about two-thirds of the coal consumed in France is raised in the country; and last year the imports amounted to 10,500,000 tons, of which quantity 6,000,000 tons were obtained from Great Britain. France being so largely dependent on Great Britain, it will readily be seen that the duration of the British coal-fields is a subject of no little importance to French economists. M. Lozé has, therefore, been induced to devote two bulky volumes, covering together 1229 pages, to a critical consideration of the investigations of Prof. Stanley Jevons, the Right Hon. Leonard H. Courtney, Mr. R. Price-Williams, Mr. T. Forster Brown, Prof. E. Hull and other English writers.

The results of his studies are grouped in four sections. The first contains an account of the geography of the British Isles, with historic, geological and economic details. The second section contains a detailed description of each of the British coal-fields, with a chapter on the coal resources of the Colonies. The third section deals with commercial geography, water and railway transport, and the principal industrial centres. The fourth and last section contains an estimate of the coal supplies of the United Kingdom, with a summary of the views expressed as to their probable duration. The work concludes with a lengthy appendix dealing with cognate matters, the production and consumption of mineral fuel in various parts of the world, the constitution of the British Colonial empire, the navy and the army.

In discussing the views of the various authorities, the author prefers to accept the pessimistic forecast of Mr. T. Forster Brown rather than the optimistic estimate of Prof. Hull. Mr. Forster Brown calculates that the amount of coal of good quality remaining in the United Kingdom at a depth not exceeding 2000 feet, the depth that he regards as the limit of economical mining, is 15,000 million tons. Such is the supply on which Great Britain must base its hopes in the inevitable economic conflict with the United States. In spite of the care and accuracy with which the divergent views on the subject are set forth, it may be doubted whether the author has made out a clear case for rejecting Prof. Hull's estimates, which show that the amount of coal remaining within a depth of 4000 feet is 81,683 million tons. The criticism of Prof. Hull's views is not convincing, inasmuch as M. Lozé, who does not appear to possess a practical knowledge of geology and mining, has not followed the recent investigations as to the limits at which mining may be carried on with profit. At the present time the greatest depth at which in Great Britain mining operations may be carried on has been reached at the Pendleton colliery, near Manchester, where the deepest workings are nearly 3500 feet below the surface. This enormous depth has, moreover, been exceeded in other countries, notably in the Lake Superior district, where a shaft of the Calumet and Hecla copper mine has now attained the record depth of 4900 feet, and in Belgium, where a colliery at Mons is 3937 feet deep. Depths such as these show that the limit of depth of 4000 feet assumed by Prof. Hull is well within the bounds of possibility. In view of the marvellous efficiency of modern winding-engines, no considerations of a mechanical nature need limit the prospective depth of shafts. By far the most important obstacle to very deep mining is the increase of temperature in proportion to the depth. Here, again, the author is apparently not familiar with recent observations. Since 1848 and 1854, the dates of observations cited by him, methods of determining earth temperatures have been greatly improved, and the results recently obtained at the Paruschowitz borehole in Silesia, put down by the Prussian Government to a depth of 6573 feet, show an increase of temperature of 1° F. for every 62·1 feet. This rate of increase would not present an insuperable obstacle to mining at a depth of 4000 feet.

The author gives in tabular form an estimate of the population, coal output, export and consumption for the years 1899 to 1950, by which date the 15,000 million tons assumed to be now remaining will be exhausted. The prosperity assured by the coal of the country to navigation, manufactures and commerce will then gradually disappear, and the historian of a powerful empire will conclude, the author prophesies, his account of a remarkable period by the words: *Finis Britanniae!* Happily, however, the array of statistics, the copious particulars of the coal-seams, and the faithfully translated estimates of eminent experts do not altogether justify the author's Cassandra-like attitude.

The work has been compiled with great care, and the author deserves high praise for the accuracy with which the names of English places and persons have been presented. On p. 564 there is a curious slip. Speaking of the introduction of railways in 1844, the author says: "Mine, aubergiste *of the George*, pleurait la fin des diligences." The archaic expression "Mine host" has proved too severe a test for the author's undoubtedly extensive knowledge of the English language.

BENNETT H. BROUGH.

OUR BOOK SHELF.

Ueber den Bau und die Entwicklung der Linse. By Dr. Carl Rabl. Pp. 324; plates 14. (Leipzig, 1900.)

IN the "Notes" column brief mention has recently been made of the concluding portion of Dr. Rabl's important investigations on the structure and development of the crystalline lens of the eye, which appeared in the *Zeitscrhift fur wiss. Zoologie.* The author has now reproduced the entire monograph as a separate work, with the original coloured plates; and since it is a most elaborate treatise on a very difficult subject, its appearance in this form should be welcomed by all students of this branch of anatomy.

There are, perhaps, few phenomena in the developmental history of animals more astounding to the ordinary mind than the fact that a structure seated so comparatively deep as is the crystalline lens of the human eye should arise from the outer, or epiblastic, layer of the embryo, and attain its permanent position, first by invagination, and then by separation from its parent layer. Nevertheless, it is a fact about which there can be no possibility of dispute; and the more superficial position occupied by the spherical lens of fishes serves, in a measure, to indicate the manner in which the conditions obtaining in the mammalian eye have been gradually evolved.

By means of the beautiful series of plates illustrating Dr. Rabl's work the student is enabled to comprehend at a glance, firstly, the mode of development of the lens respectively characteristic of fishes, amphibians, reptiles, birds and mammals; and, secondly, the different histological peculiarities presented by the lens itself in the same groups. Within the limits of a notice in this column, it is out of the question to discuss any details of the work before us; but it may be mentioned that in the concluding section the author enters into the abstruse speculation as to what may have been the degree of development of the eye in *Archaeopteryx* and other extinct animals, and also as to the gradations which may have formerly existed between the present differentiated types of lens-structure. Very interesting, too, are his observations with regard to the lens in the aborted eye of the mole. Here the rudimentary condition of the lens does not commence in the course of development, or in the fully adult animal; but it is distinctly observable in the earliest stages, when it is relatively smaller and contains fewer cells than in other mammals. Hence we have evidence of the extreme antiquity of the mole's adaptation to its present state of existence—evidence fully supported by palæontological facts.

The work may be characterised as a masterpiece of patient and careful investigation in an abstruse and difficult line of research. R. L.

Building Construction for Beginners. By J. W. Riley. Pp. vi+255. (London: Macmillan and Co., Ltd., 1899.)

THIS is an addition to the increasing number of works on Elementary Building Construction, which all have for their ultimate goal the preparation of students for the May examinations of the Department of Science and Art.

Commencing with the inevitable introductory remarks on drawing instruments and scales, the student is taken through all the various building trades, and at the end of each are added questions in the form of examination papers which should test the student's knowledge as he advances.

As the author observes, isometric projection is a very valuable means of showing the beginner exactly what is intended, as it gives in one view the plan, elevation and section of the object portrayed. We are glad to see that an extensive use is made of such a form of illustration.

We may also congratulate our author on abstaining from confusing his illustrations by figuring with too many dimensions. Some authors refer with pride to their use of such a system, but as Mr. Riley observes, it is very confusing, and tends by its complication to hinder the very object for which it is introduced.

In a new edition several small slips can be attended to, such, for instance, as the wall-plate surroundings in Fig. 384. The brickwork in this case should be taken up to the underside of the tiles. The "summary" at the end of each trade is an excellent innovation, and the book can be confidently recommended as the best of its class.

Catalogue of the Fossil Bryozoa in the Department of Geology, British Museum (Natural History). The Cretaceous Bryozoa. Vol. i. By Dr. J. W. Gregory. Pp. xiv + 457, and plates. (London: Printed by the order of the Trustees, 1899.)

WE may congratulate Dr. J. W. Gregory in having completed this volume before he left this country to take up the geological professorship at Melbourne. The value of this, and similar works, is inestimable to palæontologists in all parts of the world. The book itself is naturally a list of hard names; but it is something nowadays to know which is the correct name to apply to any particular fossil, and Dr. Gregory gives as far as possible the synonymy, diagnosis, dimensions and geological distribution of each species. A number of woodcuts in the text and seventeen excellent plates illustrate a great many of the species. We should have been glad of a table of the Cretaceous strata, to inform or remind us of the approximate British equivalents of such divisions as Rhodanian, Campanian, Hauterivian, &c., and also to indicate the sense in which the terms Neocomian and Cenomanian are used.

The volume deals with the various families which are included under the sub-orders Tubulata, Cancellata and Dactylethrata. All these are ranged under the order Cyclostomata, the sub-class Gymnolæmata, the class Ectoprocta and the group Bryozoa. It will be remembered that in the catalogue of recent marine forms in the British Museum, by Busk, that author employed the term Polyzoa instead of Bryozoa. The effort to secure a fixity in zoological nomenclature is one of the trials which beset the path of the worker. Dr. Gregory's carefully prepared catalogue will, we hope, have a permanent value in this respect.

LETTERS TO THE EDITOR.

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

The Kinetic Theory of Planetary Atmospheres.

IN the paper which I communicated to the Royal Society on April 5, I examined the logical conclusions obtained on the hypothesis that the atmosphere of a planet is distributed according to the generalised form of the Boltzmann-Maxwell distribution applicable to a gas in a field of external force, with the further generalisation required to take account of the effects of axial rotation. As regards the effects of the planet's attraction on the distribution of density, the expressions assumed to represent these were of the form now generally accepted by writers on the kinetic theory (*e.g.* Watson and Burbury), and the modifications required in taking account of centrifugal force were investigated by me in 1894, and are in harmony with the conclusions to which Maxwell's investigations tend. In the aforementioned paper I showed how to calculate a superior limit to the rate at which a planet is losing its atmosphere, and obtained the results that helium would be permanently retained at all ordinary temperatures by terrestrial gravitation and vapour of water by the gravitation on Mars; conclusions with which those deduced by Mr. Cook would appear to be identical, so far as I judge from his letter.

The objections which naturally suggest themselves to the mode of treatment in this paper are that the distribution in question is that which would be brought about exclusively as the result of molecular encounters, and of the free paths of the molecules between these encounters; and that it therefore represents the distribution in an atmosphere of uniform temperature. In an actual atmosphere the equilibrium of the lower strata is largely modified by convection currents, so that the adiabatic law, rather than the isothermal law, is applicable. This point I hope to discuss at full length in the second part of the paper; in the meanwhile, it is hardly likely that any one will suggest that helium escapes from our atmosphere because the upper strata are at a *low* temperature, but that it would cease to escape if the upper strata were heated up to the same temperature as the lower ones. The point at issue between Dr. Johnstone Stoney and Mr. Cook and myself appears to be how far the Boltzmann-Maxwell distribution represents what happens in the *upper* strata of the atmosphere. To assert "that in the present state of our knowledge it" (the *a priori* method as Dr. Stoney calls it) "cannot be made to furnish a valid investigation," seems to me tantamount to striking at the very foundations of our kinetic theories of matter. It may be that these theories will not resist such an attack, but the consequences of the onslaught cannot be properly traced, except by making mathematical determinations in the way that I have done. It appears to me to be just in this very problem of planetary atmospheres that the fundamental assumptions of the kinetic theory are least open to objections. Experiments on the relation of diffusion to temperature led Maxwell to abandon the notion that the molecules of a gas behave as elastic spheres and to consider the effects of finite intermolecular forces. So far as I am aware, (1) every attempt at a kinetic explanation of the thermodynamical properties of gases on the latter view involves some assumption which restricts its validity to the limiting case of attentuated gases, where the number of molecules within each other's sphere of influence is a negligible proportion of the whole number, and the duration of an encounter is negligible in comparison with the time of free motion between encounters. On the other hand, (2) it is amply proved by Watson and Burbury that the Boltzmann-Maxwell distribution, if it hold at any instant, will hold at all future instants in the *absence* of molecular encounters. (3) Boltzmann's minimum theorem tells us that if encounters take place at random, the molecules tend towards the distribution in question. (4) We are told on good authority that we must regard the Boltzmann-Maxwell law as a theorem in probability. Now the divergence between actual conditions and the assumptions required under heading (1) gets less and less as we ascend in the atmosphere; (3) gives us reason for believing that the Boltzmann-Maxwell distribution holds at the highest altitudes where encounters not unfrequently take place; (2) shows that the molecules which are projected from these strata and ascend to still greater altitudes without encountering other molecules remain distributed according to the same law; and (4) removes the necessity of taking the size of the element of volume $dxdydz$ into account by telling us that the law represents not merely the number of molecules having given limits of velocity occurring in the element, but also the *probability* of a molecule coming within these limits, and this probability may be as small as we please.

If helium really does escape from our atmosphere, either there must be a fallacy in the assumptions underlying (1), (2), (3), or (4), and this fallacy must affect numerous previous writings on the kinetic theory, or else our preconceived notions as to the relation between temperature and kinetic energy are at fault. With regard to (4), it may be objected that the error-law fails to apply to events of exceptional occurrence, and therefore that we cannot apply it to calculate the probability of a molecule escaping from the atmosphere when the velocity required would represent an abnormal divergence from the mean. This point was carefully considered by me. It appears, however, to be the accepted view that abnormal divergences are excluded because in practice they never occur, not because their occurrence is far more frequent than the error-law would lead us to suppose. If the methods of the kinetic theory should prove to be inapplicable to rarefied gases as well as to dense assemblages of molecules, and they do not altogether agree with experiment for distributions of intermediate density, the position is indeed a serious one. In face of such a possibility, instead of abandoning our mathematical calculations we ought to push them to their ultimate consequences, in order to arrive at a better understanding of the true state of the case. The escape of gases from the atmospheres of planets is a phenomenon probably more directly dependent on the translational kinetic energy of the molecules than any other property of gases. The prevailing doctrine that not only is the mean value of this translational kinetic energy proportional to the absolute temperature, but the conceptions of temperature and kinetic energy are physically identical, has always seemed to me to require closer investigation than it has as yet received, and it may well be that the kinetic theory of planetary atmospheres furnishes one means of putting this doctrine to a test.

Plâs Gwyn, Bangor, May 26. G. H. BRYAN.

The Severn Bore.

NO one who suffers from scientific curiosity should miss seeing a tidal bore at least once in his life. The locality and conditions under which the Severn Bore can be seen make it an ideal object for a pleasurable excursion. The time to be selected is about twenty-four hours after new or full moon; the largest spring tides should be chosen, if possible, and an occasion when the light permits both evening and morning bore to be seen. They occur at about 7.30 to 9 o'clock, a.m. and p.m. The visits should therefore be either when the days are long or at full moon. During a recent excursion, I stayed at Newnham-on-Severn, below Gloucester. This is about 3 hours 20 minutes from Paddington station, and it is possible to leave this station at 3.15 p.m. and be in time for the evening bore, see the morning bore next day, and be back at Paddington by 2.20 p.m.

On April 29, twelve hours after full moon, I awaited the bore at the south-east corner of Newnham Churchyard. The position is the summit of a cliff situated on the outer bank, and near the centre of the base of a U-shaped bend of the Severn, the limbs of the U being four miles long, and the width between the limbs two miles. The prospect is one of the most pleasing in the South of England; the broad, winding river, emerald pastures abandoned by the wandering channel, miles of rich champagne country, with apple and plum orchards, and the distant range of the Cotswolds. At 6.45 p.m. the bore was sighted as a line of white foam between Aure and Fretherne, rather more than three miles down the river. For a quarter of an hour I watched its march up stream, first wheeling by the left, then advancing up the straight reach, and finally wheeling by the right round the last bend. The wheeling movement is most fascinating to watch. I now hurried down to the ferry, and shoved off the boat into deep water to meet the bore, which was now roaring like a railway train. The water channel was about 200 yards wide; at high water it is double that width. On the sands of the opposite convex, shallow shore the bore discharged itself obliquely as a curling breaker. Against our rocky shore it was a bursting surge. A rise of level was perceptible about ten yards in front of this. In the deep channel we rode easily over a smooth wave. Against the rocky promontory which protects the landing-stage the water surged up violently, then subsided 3 or 4 feet, and surged up again more than once. We now put in behind the shelter of this promontory. At 7.15 p.m. the bore was 300 yards past the ferry, having travelled 3¼ miles, or a little more, in thirty minutes. It was due at the ferry, according to the tide-table, at 7.17 p.m. At 7.21 a steady torrent of water was pouring past the promontory. At 7.29 the torrent was roaring, and the standing waves appeared to be 3 feet high. At 7.44 the waves were

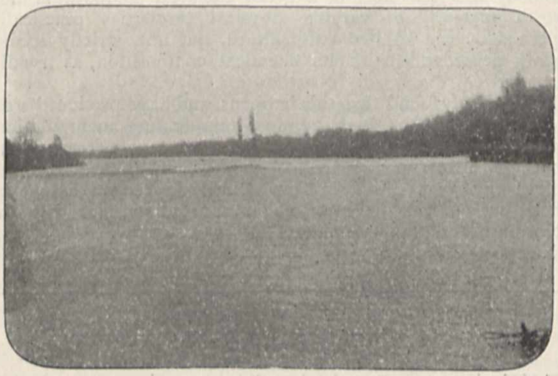

FIG. 1.—The Bore approaching.

smoothed out; the current appeared to be quite as swift, but the greatly increased depth diminishes the surface effect of the rough bottom. The boatmen tell me that the current was "logged" when a bridge was in contemplation, a velocity of 11 knots being registered. Owing to dark clouds and a lurid sunset, I took no photographs. After the passing of the bore there was half an hour's gossip at the ferry, with reminiscences of many bores.

Next morning, April 30, I got into the dog-cart at 7.30 a.m., and drove 6¼ miles, much of the way through plum orchards in

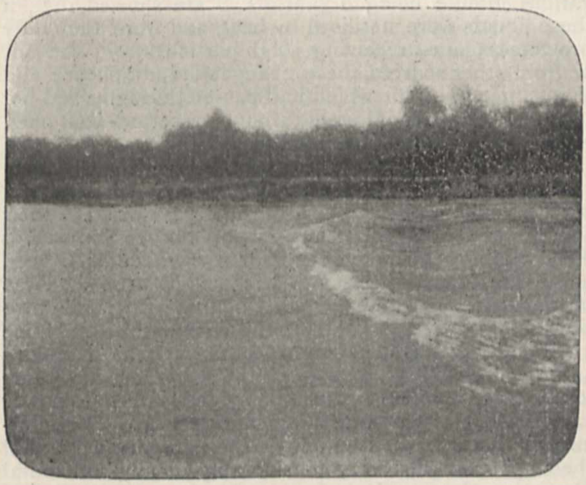

FIG. 2.—Wave Surface at Back of Bore.

full blossom, to Denny, 9¼ miles by river above Newnham Ferry. Owing to the difference of distance by road and river, it is possible to see the same bore at both places by cycling or driving; but I required spare time to arrange for photography. The clouds were heavy and a little fine rain fell at times, hence the necessarily instantaneous photographs are not as bright as they should be for successful reproduction. The spot for observation is a cottage garden by the Denny Brook. The river here is little more than 50 yards wide, flowing between steep banks, slime-covered between tide marks, with no sandy shoals. The bore appeared at 8.47 a.m., and disappeared round a bend at 8.53 a.m. Taking its time at Newnham Ferry from the tide-table, this gives 70 minutes for time of traversing 9¼ miles, or close on 8 miles an hour. The speed below Newnham was one mile per hour less than this. I guessed the height of the bore at 3 feet in the deep water, 4 feet where bursting on the outer bank. The broken water flew higher than this. These, however, are not trustworthy estimates, as I was busy photographing, obtaining seven exposures in all. Fig. 1 was taken as the bore approached; in Fig. 2 it is seen in passing, showing the wave-surface at back of the bore itself. When in the boat at Newnham I recorded the same thing as a rising and falling of the water against the bank. High water was reached about 9.40 a.m. The current continued to flow up stream; at 10 a.m. it was slack on the concave (western) shore, but still flowing in mid-stream; at 10.18 a.m. it was distinctly running down even in midstream, the water-level having already fallen nearly 3 feet. From the arrival of the bore to the complete turn of the current may be taken to be 1¼ hours.

Ordinary photographs show the form of a bore, but its character does not lie so much in its form as in its motion, which combines the mysterious, ghost-like movement of a wave with the rushing steadiness of a railway train. I hope the phenomenon may soon be cinematographed.

1, Savile Row, W. VAUGHAN CORNISH.

Bamboo Manna.

THE recent occurrence of a sweet secretion on the stems of bamboos growing in the Central Provinces is a most interesting fact to students of antiquarian medicine. Bamboo manna derives its name from the Sanskrit words—Tvak-kshira, "bark milk"; Vanśa-sarkara, "bamboo sugar"; and Vanśa-karpura, "bamboo camphor." Vanśa-lochana is the name by which it is known by Indian physicians at the present day. These terms would signify a manna-like substance exuding from the stem of the tree, but what is known and used as Vansa-lochana all over India is quite a different article.

That bamboo manna is not a sugar, but a white, gritty body, now called Tabáshir by Europeans, is gathered from the account of Dioscorides, and from the fact that no kind of sugar prepared from the sugar cane answering to this description was known in India in his time. Dioscorides writes: "What is called *σάκχαρον* is a kind of concrete honey, found in reeds in India and Arabia Felix, in consistence like salt, and brittle between the teeth like salt." Tabáshir, or bamboo manna, was known to the early Arab travellers in the East, and the port of Thana, on the western coast of India, was famous for this product in the twelfth century. Tabáshir is employed as a medicine for its cooling, tonic, aphrodisiac and pectoral properties. In its crude state, when taken from the inside of the bamboo stems, it is mixed with insect remains, and has a blackish appearance; but on gently calcining it becomes quite white, with a pearly lustre. It consists of about 80 per cent. of pure silica, with variable proportions of alkalis, water and organic matter. The history and properties of tabáshir have been very fully discussed by Sir David Brewster (*Philos. Trans.* 1819; *Edin. Journ. Science*, vol. viii. p. 286); Sir George Birdwood (*Bombay Products*, pp. 95-96); Dr. F. A. Flückiger (*Zeit. des Allg. Osterr. Apoth. Ver.* 1887, No. 14), and by Sir D. Brandis (*Indian Forester*, March 1887).

The only modern work which alludes to a sugar in the bamboo is the "System of Botany," by La Maout and Decaisne. The authors remark:—"The young shoots of these two trees (*Bambusa arundinacea* and *B. verticellata*) contain a sugary pith which the Indians seek eagerly; when they have acquired more solidity, a liquid flows spontaneously from their nodes, and is converted by the action of the sun into drops of true sugar. The internodes of the stem often contain silicious concretions, of an opaline nature, named tabáshir." Here a distinction is made between the manna forming on the outside of the stem and the tabáshir found inside, but no reference is made to any record where the first named exudation was observed or examined. Dr Watt, when writing the article on Bambusa for his "Dictionary of Economic Products of India," sums up the general experience with regard to this point, and says: "nor has the spontaneous excretion of sugar on the outside of the stem ever been recorded by Indian travellers."

The strange appearance of manna on the stems of the bamboo was reported last March by the Divisional Forest Officer, Chanda, Central Provinces, and notices of this phenomenon have been published in the local papers. The bamboo forests of Chanda consist of *Dendrocalamus strictus*, the male bamboo, a bushy plant from 20 to 30 feet in height, and affecting the cooler northerly and westerly slopes of Central and Southern India. This is said to be the first time in the history of these forests that a sweet and gummy substance has been known to exude from the trees. The gum has been exuding in some abundance, and it has been found very palatable to the natives in the neighbourhood, who have been consuming it as a food. The occurrence of the manna at this season is all the more remarkable, since the greatest famine India has known is this year visiting the country, and the districts where the scarcity is most keenly felt are in the Central Provinces.

An authentic specimen of this bamboo manna was sent to Dr. Watt, Reporter on Economic Products, Calcutta, and was subsequently handed to me for examination. It occurred in short stalactiform rods about an inch long, white or light brown in colour, more or less cylindrical in shape, but flattened or grooved on one side where the tear had adhered to the stem. It was pleasantly sweet, without the peculiar mawkish taste of Sicilian manna (*Fraxinus rotundifolia*). It was soluble in less than its own weight of water, and the solution when allowed to repose deposited white, transparent crystals of sugar. The manna contained 2·66 per cent. of moisture, 0·96 per cent. of ash, 0·75 per cent. of a substance reducing Fehling solution, and a small quantity of nitrogenous matter. The remainder consisted of a sugar which became inverted in twenty minutes when boiled with dilute hydrochloric acid (1 per cent.), and from its solubility, melting-point and crystalline nature, appeared to be a saccharose, related to, if not identical with, cane sugar. It contained no mannite, the saccharine principle peculiar to true manna.

The bamboos and sugar canes belong to the same natural order of grasses, and perhaps it is not unnatural to expect them to yield a similar sweet substance which can be used as a food; but it is a coincidence that the culms of the bamboo, hitherto regarded as dry and barren, should in a time of great scarcity afford sustenance for a famine-stricken people.

Indian Museum, Calcutta, May 3. DAVID HOOPER.

Solution Theory Applied to Molten Iron and Steel.

I AM pleased to notice that the theory of solution of iron and steel has recently received attention, and that valuable work has been placed before us for consideration by Baron von Juptner (see recent proceedings of the Iron and Steel Institute).

Will you, however, permit me to state that many years ago, in a contribution to the Institute (*Iron and Steel Inst.* 1881), I advocated the theory of solution in the following words:—

"The solution theory is directly applicable to fluid iron and steel, as it is to water. Carbon, phosphorus, &c., are more or less soluble in the fluid metal, just as salts are soluble in water; in both cases the same forces are at work; water, however, at the normal temperature of 60° Fahr., fluid iron about 2500°–3500° Fahr."

"Further, the physical or gaseous theory of solution best explains the facts; the so-called chemical theory of solution is not so applicable. It is difficult to give satisfactory reasons for the union of stable bodies such as carbon and iron, but the gaseous theory of solution apparently does so.

"The difficulty of its complete or further application becomes one of degree only, for no definite distinction can be drawn between gases, liquids and solids, more especially when the latter are heated.

"The quantity of matter dissolved in a given time is simply a function of temperature, and at low osmotic pressure is comparable with that of a liquid evaporating under the pressure of its own vapour" (NATURE, 1892).

"Moreover, it is remarked that ordinary soft steels for sheets, rails, &c., should be so manipulated as to produce a colloid, or, as near as possible, a non-crystalline material, avoiding always the formation of large crystals" (*Iron and Steel Inst.* 1881).

In my practice I have always adhered to the solution theory, finding that it gave the key to the solution of many discrepancies observed in the manufacture of steel, which ordinary analysis, and the usual theoretical deductions therefrom, sometimes failed to explain.

It appears to me, however, that the solution theory requires extension. We have, I think, up to the present only touched upon the surface of the matter, and more extended and deeper research will amply repay those who have already done work in this direction.

In connection with this subject, although perhaps not exactly bearing upon it, there is what may be termed the theory of the crystallisation of steel and iron. A sheet of ice, as is well known, shows, when heated, beautiful structural, or more correctly crystalline, changes. Why should not a steel plate exhibit changes of this kind if similarly treated?

It is evident, as has been remarked of others, that if the sheet of either ice or iron be suddenly cooled at a given temperature, the structure or grain at that temperature will be approximately retained, and that steel of a given chemical composition may give a material of varying physical properties practically governed by the applied temperature, but not, strictly speaking, in accordance with its chemical composition, as usually assumed.

I have lately found that this happens, and have produced steel of four degrees of hardness by mere temperature manipulation, with metal containing only one-tenth per cent. of carbon together with low per cents. of sulphur and phosphorus. I believe also that this has been done to a certain extent by others, but the facts have not, so far as I know, met with the attention of the practical manufacturers of steel.

Newport, Mon., May 16. JOHN PARRY.

THE BACTERIAL TREATMENT OF SEWAGE.

THE discovery made by Schwann, in 1839, that a putrefying liquid swarmed with microscopic living organisms, gave occasion to a long series of remarkable investigations as to the general nature and the life-history of these organisms, and the chemical changes which they produced.

Prominent amongst the names of those who prosecuted these investigations stands that of Pasteur, who, in 1857, drew attention to the nature and causes of fermentative changes produced upon sugar solution, of the putrefactive changes in liquids containing animal substances, and of disease changes in the blood of the living animal, which were produced in the presence of various minute living organisms. He showed that, if these liquids were sterilised by heat, and were then duly protected against receiving solid particles from the air, or from other sources, these changes did not occur; and that contact with air which had passed through a red-hot tube, or had been filtered through a cotton-wool plug, was incompetent to introduce the organisms and to start the above changes.

These researches drew attention to the important part played by the air as a vehicle of the organisms or of their spores, and was supplemented by the researches of Tyndall (1876), who proved that air which had been allowed to remain at rest until its motes had subsided was incompetent to produce putrefaction. Tyndall also proved that boiled sterilised broth, when opened in Alpine air, did not usually putrefy, and that the air near the earth's surface in different localities, and even in the same locality at different times, possessed infective power varying from nil to something considerable. The inference is that the distribution of these organisms and of their spores varies very considerably in any horizontal plane near the earth's surface.

Percy Frankland (1886) determined the number of these living organisms which could be developed from equal volumes of air collected at varying heights from the earth's surface. He made use of hills and cathedral towers for the purpose of collecting his samples, and noted a regular decrease in the number of the organisms which were in the air at greater and greater distances from the earth's surface.

These typical researches render it evident that the organisms and their spores, which are produced at or near the earth's surface, are wafted by natural atmospheric movements to some height, but are constantly tending to subside, and to sow the organisms broadcast as they descend.

It has been shown by more recent bacteriological investigations that many of these minute organisms are normally present in the living organism, and make their appearance in large numbers in the dejecta. It is therefore not remarkable that sewage, which contains the dejecta of men and animals, as well as the washings of considerable road and other surfaces, should contain micro-organisms and their spores in large number.

The fact that animal dejecta and sewage are inoffensively and gradually resolved into simple chemical compounds by contact with different kinds of soil has long been known, but this resolution has, until recently, been attributed to the purifying action of the earth itself, or of the organisms which it may contain. It is now abundantly proved that the resolving or purifying agents are, in the main, the micro-organisms which were originally present in the dejecta themselves, although undoubtedly organisms derived from the air, and those already present in the soil, contribute to the change when they are present.

The experimental purification of sewage by letting it stand in tanks filled with flints, gravel, coal, coke or other mineral substances, proves that there is no special virtue in soil. These experiments, originally commenced by the Massachusetts Board of Health, in 1887, have been repeated by many public sanitary authorities, and their results have been abundantly verified; and in various localities broken stone, broken slate, broken clay vessels, "ballast" or burnt clay have been successfully employed in the tanks in place of the materials which were originally used.

For the successful and inoffensive treatment of sewage by this means, a preliminary "priming" of the material is necessary. This is effected by allowing it to remain immersed in sewage for several hours daily for a few weeks. Sewage, which is then introduced and allowed to remain for a few hours in the tank containing the "primed" coke or other material, has the amount of its putrescible dissolved matters considerably and rapidly reduced, while its solid, finely-divided fæcal matter is brought into solution, and caused to undergo, in large measure, inoffensive resolution into simple compounds.

In order that these changes may be completed inoffensively, it is necessary that the "primed" coke surfaces shall be frequently placed in contact with air, and the process is therefore an intermittent one. The coke-bed is first filled with sewage, which is then allowed to flow out from the bottom and to draw air into the interstices of the coke. After the coke surfaces have been for several hours in contact with the air, the cycle of processes is then repeated. The treatment of fresh quantities of sewage in the same coke-bed may apparently be continued indefinitely.

The effluent from one coke-bed undergoes a considerable further purification if it is made to undergo similar treatment in a second coke-bed; and if this second contact with the coke surfaces is followed by ordinary sand filtration, such as is usually applied to river-water which is to be used for drinking purposes, an effluent of extraordinary purity is obtained.

The original methods introduced by the Massachusetts experiments, and known as the intermittent aërobic treatment, is sometimes preceded by a preliminary anaërobic treatment. This consists in allowing the sewage to remain quiescent in, or to flow very slowly through, a large tank or channel. A thick, tough scum soon forms upon its surface, and protects the liquid from the air. Under these conditions many of the solid suspended particles of an organic nature pass into solution, and are thus rendered rapidly resolvable by subsequent aërobic intermittent treatment.

The above general description of the bacterial treatment of sewage has been subjected to modification as to details to suit the conditions of particular localities. Thus the sewage is in some places subdivided by suitable mechanical arrangements into drops, and allowed to fall continuously like rain upon the surface of the coke-bed. The bed never becomes full of liquid, since when the sewage has trickled through the coke, and has been exposed to the coke surfaces and to the interstitial air, it is at once allowed to flow away from the bottom of the bed.

That these methods of purifying sewage are correctly described as bacterial has been placed beyond doubt. Any conditions which are unfavourable to bacterial life at once retard the purification, while any treatment of the sewage which sterilises it arrests the purification entirely.

The bacteria in the sewage are considered to be the active agents, producing the changes either directly or indirectly through their products or enzymes. Bacteria and their spores are found to be present in great numbers in sewage. London sewage has been shown by Dr. Houston and others to contain very large numbers of bacteria, varying from about three to six million per

FIG. 1.—*Proteus vulgaris.* Impression preparation from "swarming islands" on gelatine; 20 hours' growth at 20° C. × 3000. (Houston.)

cubic centimetre. It seems probable that many of these bacteria form films, or "swarming islands," on the coke surfaces, similar to those which are produced by their growth upon the surface of a gelatine film (Fig. 1); the period of formation of these films may be assumed to be the period of "priming" already referred to. Probably the coke-bed aids bacterial action largely by furnishing surfaces of attachment to the bacteria, upon which they may alternately be exposed to air and to the sewage. The useful effect of solid surfaces in promoting bacterial action in the case of other similar changes is well-known, and it may be connected with the effect which the surfaces exert in preventing the settling of the bacteria to the bottom of the liquid.

Sewage contains many different species of bacteria, some of which have been described and figured by Dr. Houston.[1] As is seen in Figs. 2, 3, 4, some of these

[1] The illustrative figures in this article have been selected from Reports on "The Bacteriology of London Crude Sewage" and on "The Bacterial Treatment of Crude Sewage," by Dr. Clowes and Dr. Houston, issued by the London County Council (F. S. King and Son); they were originally produced from micro-photographs taken by Dr. Norman from Dr. Houston's cultivations.

bacteria possess motile tail-like flagella, and by the movement of these the minute organisms maintain a rapid progress through the liquid. Bacteria which are devoid of flagella, and cannot traverse free paths in the liquid, are shown in Figs. 5, 6, 7 and 8. In Fig. 9, the spores of these minute vegetable organisms are seen interspersed amongst the organisms themselves. The organisms have

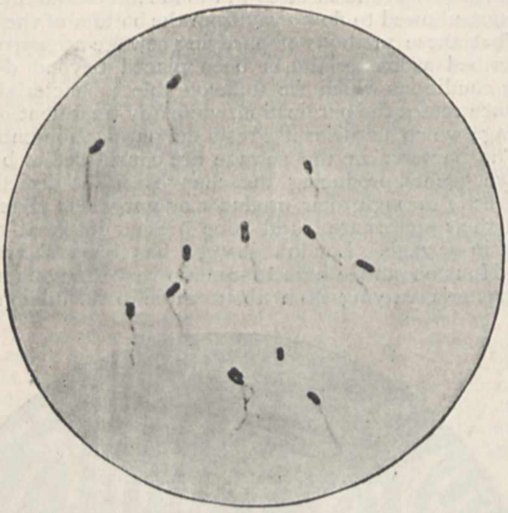

FIG. 2.—"Sewage proteus." Microscopic preparation stained by V. Ermengem's method, showing one flagellum at the end of each rod; from a 24 hours' growth agar culture at 20° C. × 1000.

two methods of multiplying, by fission and by producing spores: the spores have great power of retaining vitality. It is found that none of these bacteria are selectively retained by a coarse coke-bed during the treatment, but that all the species make their appearance in but slightly diminished numbers in the purified effluent from the coke-bed. The average reduction in number of bacteria

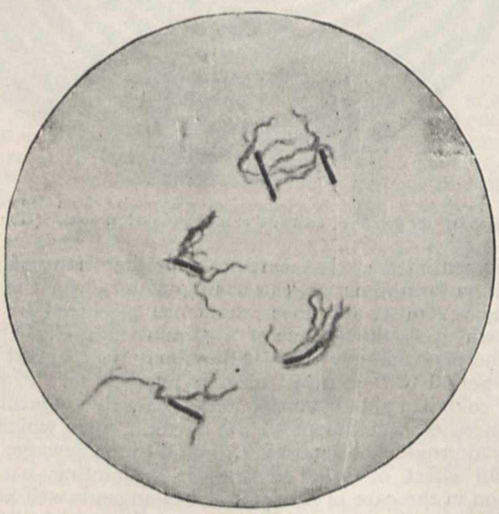

FIG. 3.—*B. mesentericus.* Sewage variety E. Microscopic preparation stained by V. Ermengem's method, showing numerous flagella, from a 20 hours' agar culture at 20° C. × 1000.

suffered by the sewage by one treatment in a coarse coke-bed amounted to only 27·7 per cent. It would therefore appear that the different species of bacteria assist one another in the purifying action, and by producing either contemporaneous or consecutive effects upon the sewage secure its purification: in bacteriological language, their action is either symbiotic or metabiotic, or possibly of both kinds. The organisms seem to establish and maintain a condition of equilibrium amongst themselves in the coke-bed, since attempts to artificially increase the number of certain species have thus far failed.

It appears that in the above processes there is no separation of the bacterial action which takes place in

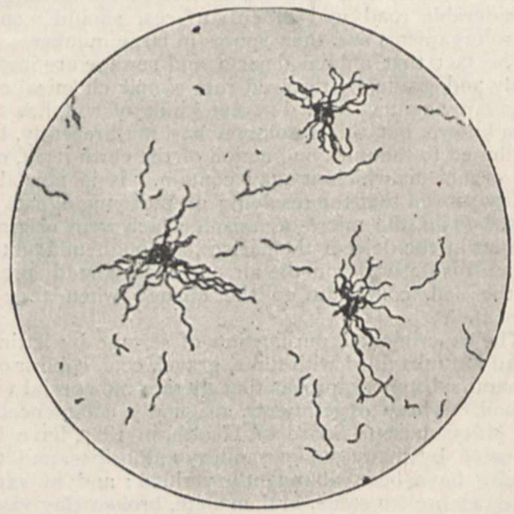

FIG. 4.—*B. mesentericus.* Sewage variety I. Microscopic preparation stained by V. Ermengem's method, showing numerous flagella; from a 20 hours' agar culture at 20° C. × 1000.

the presence of air from that which occurs only in the absence of air, and both processes probably proceed side by side in the open coke-bed. The anaërobic, or so-called "septic," treatment, during which cellulose is slowly resolved with separation of hydrogen and methane, is, however, sometimes made to precede the more truly aërobic treatment.

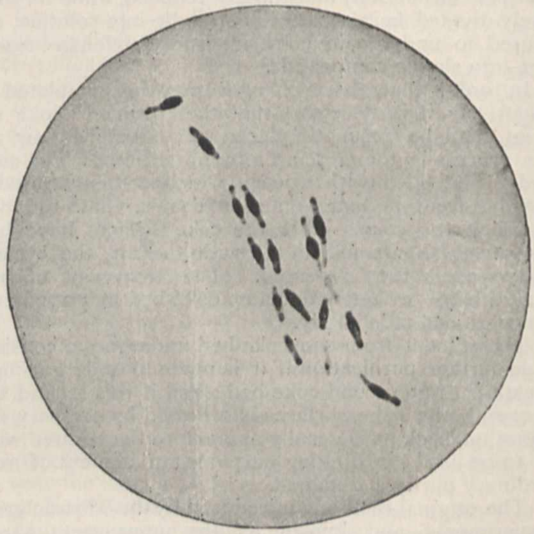

FIG. 5.—*Bacillus subtilis.* × 1500.

One result of the anaërobic treatment is the liberation of large volumes of combustible gas, and this gas has been employed at some works for illuminating purposes on the incandescent principle.

The general products from both processes of bacterial action are carbon dioxide, water, ammonia, nitrogen, hydrogen and methane; and in the aërobic changes the ammonia is subsequently oxidised into nitrite and nitrate.

The experience obtained from several years' experimental bacterial treatment of sewage at several of our largest cities has recently been published.

In 1893 the London County Council constructed an acre coke-bed about three feet in depth at the Barking Outfall of the North London Sewage. This bed has been continuously reduced by the deposition upon the coke of mineral matter from road detritus, of particles of straw, chaff and woody matter from the horse-traffic and from the wood pavements. It was, therefore, evident that these matters must be deposited by sedimentation before the sewage was brought into the coke-beds. A comparatively

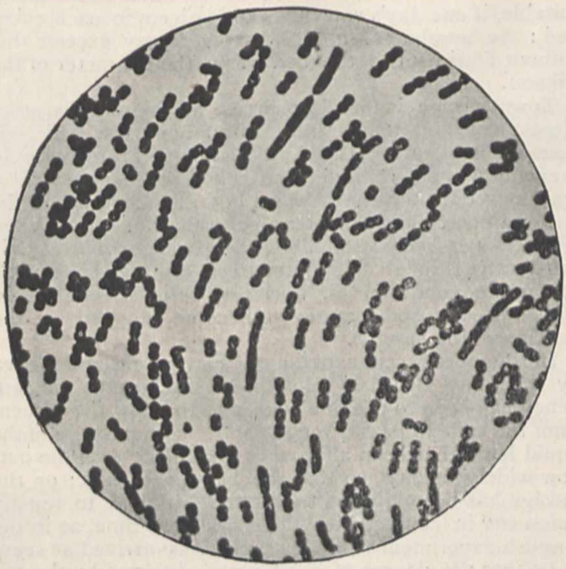

FIG. 6.—*B. subtilissmus.* Impression preparation from a gelatine plate culture. × 1000.

FIG. 8.—*B. enteritidis sporogenes* (Klein). Microscopic double-stained preparation, from a serum culture, showing spores. × 2000.

receiving screened and sedimented sewage up to the present time, the process of sedimentation having been assisted by the addition of a small proportion of solutions of lime and of ferrous sulphate. Two years ago the bed was deepened to about six feet. Its purifying action, as measured by the amount of oxidisable matter present in rapid process of sedimentation suffices to remove these matters, since even the cellulose matters arrive in the sewage in a heavy and waterlogged condition.

It was found advantageous to use coke in comparatively large fragments, about the size of walnuts, since this facilitated the rapid draining of the liquid from the coke,

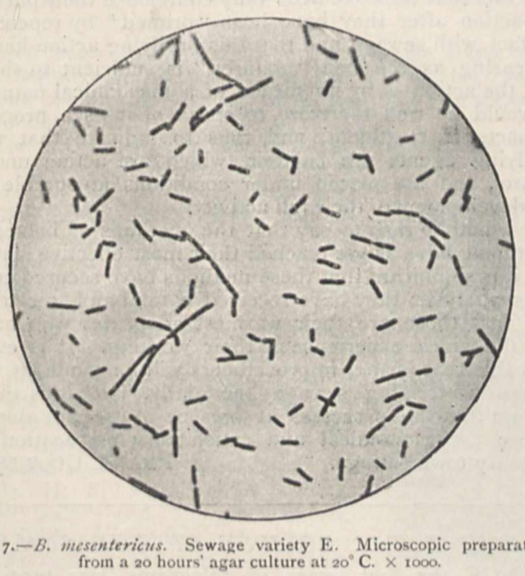

FIG. 7.—*B. mesentericus.* Sewage variety E. Microscopic preparation from a 20 hours' agar culture at 20° C. × 1000.

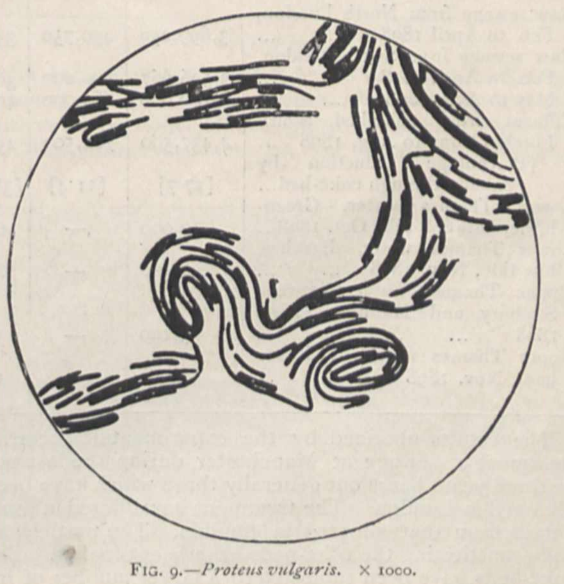

FIG. 9.—*Proteus vulgaris.* × 1000.

the raw sewage and in the clear effluent, amounts to 92 per cent., and if the purification is calculated from the clear sewage and effluent, it amounts to 84 per cent. More recent experiments have proved that the treatment of raw, roughly-screened sewage in such coke-beds is satisfactory, but that the capacity of the bed becomes and at the same time increased the sewage capacity of the bed and promoted its efficient aëration. The depth of the beds has been augmented from 4 to 13 feet, and the increase of depth seems to be attended with increase of efficiency. The 13-foot bed has for long periods given a purification from dissolved oxidisable matter of over

60 per cent. It has maintained a most satisfactory state of aëration, since the air drawn from the bottom has contained, on an average, 17 per cent. of oxygen.

About 60 per cent. of the matter which settles from the sewage under ordinary conditions is combustible, and could, therefore, very well be dealt with by a destructor.

The tendency of the coke bacteria beds is undoubtedly to improve in their purifying power with age, provided they are not overworked. A bed which had given for some time a 50 per cent. purification, gradually increased in efficiency until its purifying effect reached nearly 70 per cent. The effluent from this bed underwent an additional purification of 20 per cent. by treatment in a second similar bed.

The effluent from a single coke-bed worked on the intermittent principle was clear and odourless, and remained in this condition when it was kept in open or closed bottles in a warm laboratory. It maintained the life of gold-fish, roach, dace and pike indefinitely: it was therefore not only well aërated, but was able to maintain its aërated condition. This proves that it was free from any rapidly oxidisable matter. It was undoubtedly, however, undergoing gradually further purification by the action of the bacteria which it contained, and with the assistance of dissolved oxygen. Such an effluent would be quite suitable for introduction into the tidal part of the river, where the water is too salt and muddy to be used for drinking purposes.

Bacteria are present in large numbers in the river-water itself, and undoubtedly exert a most useful purifying effect upon the water during its flow. The relation between the number present in the sewage and in the water of the River Thames, below and above locks, is shown by the following estimations made by Dr. Houston. The number of liquefying bacteria included in the total number of bacteria present in one cubic centimetre, and the number of spores of bacteria, are also stated:—

	Bacteria.	Liquefying bacteria.	Spores.
Raw sewage from North London, Feb. to April 1898	3,899,259	430,750	332
Raw sewage from South London, Feb. to April 1898	3,526,667	400,000	365
May to Aug. 1898	6,140,000	860,000	407
Effluent from coke-bed, South London, May to Aug. 1898 ...	4,437,500	762,500	252
[Percentage reduction by passing through coke-bed...	[27·7]	[11·4]	[38]
Lower Thames water, Greenhithe, half ebb-tide, Oct. 1898...	10,000	—	63
Lower Thames water, Barking, low tide, Nov. 1898	34,400	—	89
Upper Thames water, between Sunbury and Hampton, Nov. 1898	5,100	—	56
Upper Thames water, Twickenham, Nov. 1898	3,000	—	18

The results obtained by the experimental bacterial treatment of sewage at Manchester during the last two or three years bears out generally those which have been obtained in London. The treatment has differed in some details from that adopted in London. The particles of coke constituting the coke-beds have been smaller. The coke-beds have been subjected to a larger number of intermittent fillings per day; and the preliminary treatment in an open anaërobic tank has been carried out with advantageous results. The scientific experts who have suggested and watched the experiments state their conviction that bacterial treatment is the treatment which is most suitable for Manchester sewage, but that in order to secure the most effective purification, the coke-beds must have sufficiently frequent and prolonged periods of rest, and must be fed with sewage as free as possible from suspended matter, and as uniform in quality as may be. Preliminary anaërobic treatment is referred to as the best means of securing uniformity in quality of the sewage, and of adapting it to rapid subsequent aërobic purification. Four fillings in 24 hours have been found suitable, if one day's rest in seven is given to each coke-bed; the number of fillings, however, may exceed this without detriment to the bed or to the character of the effluent.

Town sewage is found to arrive at the outfalls at an almost constant temperature throughout the year. It rarely falls below 13° C. And this temperature not only prevents the possibility of the coke-beds being stopped by the freezing of the sewage, but also secures to the bacteria one condition favourable to their action. When a bed is too freely aërated by the passage of frosty air constantly through the interstices of the coke, this favourable condition is, however, seriously interfered with, and the bed may even become stopped by the freezing of the sewage.

In the more recent experiments carried out in America by the State Board of Health, Massachusetts, the tendency has been to use fine coke, and to allow the effluent from the coke to pass through sand. The passage of the liquid has either been allowed to take place with the outflow widely opened, so that the bed never fills; or the sewage has been allowed to fill the bed and to remain quiescent in contact with the coke for a time, as in the English experiments. The conclusions arrived at seem to be that the degree of purification obtained by the use of fine coke and sand is very satisfactory, but that the volume of sewage dealt with in a given time is smaller than when larger coke fragments are used, and the tendency seems to be to adopt the larger coke in order to expedite the more rapid drainage away of the effluent.

It will be seen from what has already been said that it is well not to speak of this system of treatment as one of filtration. Filtration ordinarily implies a process of mechanical separation of material suspended in a liquid. The fact that the coke-beds only commence their purifying action after they have been "primed" by repeated contact with sewage, and that this purifying action keeps increasing as the bed "matures," is sufficient to show that the action is by no means of a mechanical nature. It would be well, therefore, to speak of it as a process of bacterial treatment, and thus to indicate that the purifying agents are bacteria, which are acting under control, and are placed under conditions favourable to the development of their full activity.

It would be rash to say that the methods of bacterial treatment have as yet reached their most effective state; but it is significant that these methods have secured converts wherever they have received careful and fair trial, and that those are their warmest advocates who have had the widest experience of their working. It is even probable that further improvements will be made in the means of treating sewage bacterially, but it is quite certain that the processes at present in use are able to secure the economical and satisfactory purification of ordinary town sewage. FRANK CLOWES.

THE TOTAL ECLIPSE OF THE SUN.

SINCE the first series of telegrams was received announcing successful observations of the total eclipse of the sun on May 28, all the more detailed reports to hand confirm the universal satisfaction of the various parties at the results. As, however, most of the parties having a definite programme arranged to obtain photographic records, complete details cannot be known until the development of the whole of the plates, and in some cases this will not be until the observers return home.

Rough prints from several of the negatives obtained with the prismatic cameras used by Sir Norman Lockyer's party show as great amount of detail as those taken in 1898. From a cursory examination of the negatives few differences appear in the chromospheric spectrum; the "1474" corona ring seems, however, slightly more feeble than before.

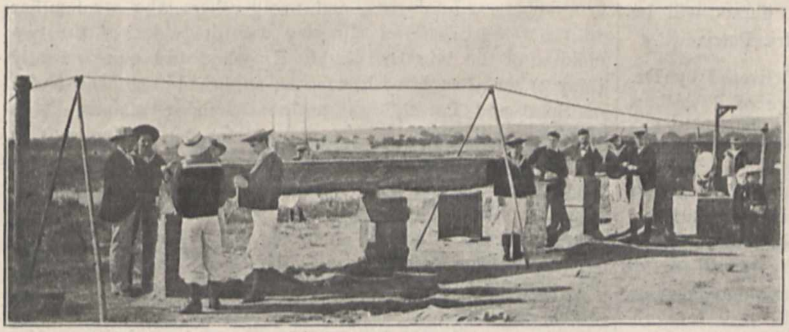

FIG 1.—Two of the cameras fed by a cœlostat.

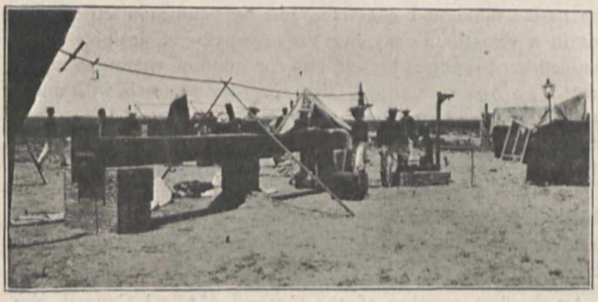

FIG. 2.—The 20-foot prismatic camera and siderostat.

In a letter received from Mr. Fowler he states that the negatives obtained by Mr. Payn with the 16-foot Cooke coronagraph are excellent, especially one showing the inner corona.

The accompanying illustrations, received too late for reproduction with Sir Norman Lockyer's letter last week, show some of the arrangements made for observing the eclipse at Santa Pola. Particulars concerning the various instruments will be found in NATURE of May 17.

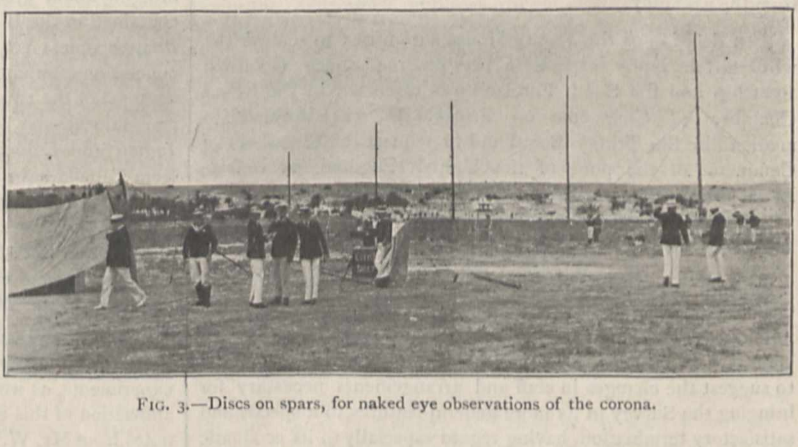

FIG. 3.—Discs on spars, for naked eye observations of the corona.

Prof. H. H. Turner, at Bonsarea, near Algiers, successfully carried out his programme of photographing the corona, obtaining seven ordinary pictures and seven with interposed polarising apparatus. The polarisation indicated was decidedly radial.

Mr. H. F. Newall obtained the "first flash" and "corona" spectra with both slit spectroscope and objective grating, those taken with the latter, however, being weak. With Mrs. Newall he also made polariscopic observations.

Mr. W. H. Wesley made an excellent drawing from his observations with the eight-inch Coudé equatorial placed at his disposal by M. Trèpied, director of the French observatory at Algiers. He reports that very little structural detail was discernible in the inner corona.

The need for correction of the lunar tables is indicated by the universal experience that totality was some seconds *less* than that previously computed. The American observers estimate the difference as three seconds, while at Ovar, in Portugal, Mr. W. H. M. Christie, the Astronomer Royal, gives the time of totality as 85 seconds, whereas the calculated value was 93 seconds. Several observations indicate that the discrepancy is to be looked for in the moon's diameter being taken too large.

The most unfortunate victim of this error appears to have been Mr. Evershed, who journeyed to an outlying station, near Mazafran, so close to the limiting line of totality as was considered safe. He did this with the object of photographing the "flash" spectrum with as long duration as possible; this will be understood when it is considered that exactly on the central line the duration of the flash will be merely momentary, but as the observer recedes from the central line the line of sight to the moon's limb becomes more oblique, until on the limiting line of totality the so-called "flash" is visible for the whole time of totality at that point. Owing to this ambiguity of the data, the station chosen was evidently somewhat further from the central line than was anticipated, and consequently Mr. Evershed had the unpleasant experience of less than one second totality. His preparations must have been exceedingly perfect, however, for he reports having obtained a good photograph at the proper instant, though it will fall short of expectation for the reason stated.

Prof. Howe, of Denver, has already determined the position of the planet Eros, which he was fortunate enough to discover on his photographic plates during the eclipse, and has circulated his result. The coordinates of the planet will be found in the "Astronomical Column."

C. P. B.

NOTES.

SIR ARCHIBALD GEIKIE, F.R.S., has been elected a Foreign Honorary Member of the American Academy of Arts and Sciences in the section of Geology, Mineralogy and Physics of the Globe, in succession to the late Carl Friedrich Rammelsberg.

PROF. FOUQUE has been elected vice-president of the Paris Academy of Sciences for the year 1900, in succession to the late Prof. Milne-Edwards. Prof. Boltzmann has been elected to succeed the late Prof. Beltrami, in the mechanics section of the Academy.

PROF. PAUL GROTH, of Munich, has been elected a Foreign Member of the Geological Society, and Prof. A. Issel, of Genoa, a Foreign Correspondent.

THE annual conversazione of the Institution of Electrical Engineers will be held on Tuesday, June 26, at the Natural History Museum, South Kensington. The guests will be received by the president (Prof. Perry), and Mrs. Perry.

THE Croonian Lectures for 1900 will be delivered by Dr. F. W. Mott, F.R.S., before the Royal College of Physicians of London, on June 19, 21, 26 and 28. The subject is "The Degeneration of the Neurone."

IT is stated that Captain W. Bade di Wismar has organised an expedition to the east coast of Spitsbergen and Franz Josef Land to seek for traces of Andrée, and also to obtain intelligence of the Duke of the Abruzzi. No apprehension is felt about the Duke of the Abruzzi, as a long interruption in his communications with the rest of the world was foreseen.

A MEETING was held at the Meteorological Society on Thursday last to consider the question of a memorial of the late Mr. G. J. Symons, F.R.S. It was resolved that the memorial should take the form of a gold medal, to be awarded from time to time by the council of the Royal Meteorological Society for distinguished work in connection with meteorological science. An executive committee was appointed to take the necessary steps to raise a fund for this purpose. Contributions will be received by the assistant secretary, Mr. W. Marriott.

LORD LISTER will open the new clinical laboratories at the Westminster Hospital on Tuesday, June 12, at 4 p.m. He will be received by Sir J. Wolfe-Barry, chairman of the committee, and supported by Lord Kelvin, Sir Michael Foster, M.P., Dr. Church, president of the Royal College of Physicians, Sir William MacCormac, president of the Royal College of Surgeons, and the Dean of Westminster.

THE completion of the twenty-fifth year of teaching by Prof. Luciani, Rector of the University of Rome, was celebrated on May 3 in the physiological laboratory of the University. The *British Medical Journal* states that the theatre was crowded with admirers of the well-known physiologist, conspicuous among whom was Prof. Baccelli. An address was delivered by Prof. Todaro, to which Prof. Luciani, who was much moved, replied. Prof. Baccelli also spoke, and ended by embracing Prof. Luciani, who was the object of enthusiastic congratulations from the assembly.

THE decision of the Trinity House authorities to remove the wireless telegraphy installation between the South Goodwin lightship and the South Foreland was discussed by the Dover Chamber of Commerce on Friday. It was decided to memorialise the Trinity Board and to request the Chambers of Commerce of the ports of the United Kingdom, as well as Lloyd's and other shipping bodies, to support the memorial, with a view to the establishment of a connection between lightships and the shore on dangerous sands.

THE president of the Board of Education has approved of a Committee, which is now sitting, "to inquire into the organisation and staff of the Geological Survey and Museum of Practical Geology; to report on the progress of the Survey since 1881; to suggest the changes in staff and arrangements necessary for bringing the Survey in its more general features to a speedy and satisfactory termination, having regard especially to its economic importance; and, further, to report on the desirability, or otherwise, of transferring the Survey to another public department." The members of the Committee are:—The Right Hon. J. L. Wharton, M.P. (chairman), Mr. Stephen E. Spring Rice, C.B., Mr. T. H. Elliott, C.B., General Festing, C.B., Dr. H. F. Parsons, Mr. W. T. Blanford, F.R.S., and Prof. C. Lapworth, F.R.S., with Mr. A. E. Cooper as secretary.

THE announcement of the death of Miss Mary H. Kingsley, at Simonstown, on Friday, will be received with deep regret by geographers, ethnologists, and many others who are familiar with her works. Miss Kingsley was the elder of the two children of the late Dr. G. H. Kingsley, and quite recently (May 3) her memoir of her father, published with his "Notes on Sport and Travel," was noticed in these columns. Miss Kingsley will chiefly be remembered for her explorations in West Africa, and her works upon them. The first volume in which she recorded her experiences was "Travels in West Africa," published in 1897. Last year, a further volume of "West African Studies" appeared, and a few weeks ago her "Story of West Africa" was published in the Empire Series. Miss Kingsley's books are marked by a sincerity and humour which make them of deep interest even to readers who may not always agree with her forcibly-expressed convictions. Her interest in West Africa, as an obituary notice in the *Times* points out, was partly scientific, partly sociological, partly political. She made numerous contributions to our knowledge of the fishes of some of the West African rivers, and of the reptiles in that part of the continent. In both her books on West Africa she made valuable additions to our knowledge of the native mind and character, and her studies in fetish bring out in a remarkable manner the sympathetic insight which enabled her to project herself into the mind of the negro races. In "West African Studies" Miss Kingsley set forth, with much array of facts and arguments, a strong indictment of the system of government by Crown colonies in West Africa. Personally, Miss Kingsley was of a modest and retiring disposition; but the frequent journeys that she made up African rivers and through the bush with none but native attendants afforded undoubted testimony to her pluck, powers of endurance and fertility of resource.

AT the last meeting of the General Medical Council, the report of the Pharmacopœia Committee, referring to the subject of a proposed international Pharmacopœia limited to drugs of a drastic nature, was adopted. If an international conference on the subject in question is arranged, the Council will appoint representatives to participate in it, and one or more members will be appointed to act as delegates. Communications have been opened with the United States authorities with a view to bringing about greater uniformity in the official preparations contained in the British Pharmacopœia and the United States Pharmacopœia respectively; and it is hoped that, by mutual concessions, important approximations and assimilations in the contents of the two works may be ultimately secured. Further communications have been received with reference to the Indian and Colonial "Addendum," and important suggestions from Canada have been considered by the committee in detail. It is hoped that the addendum will be authorised for issue by the end of the year. By the efforts of Dr. Leech, a valuable collection of British and foreign works bearing on the history and development of the Pharmacopœia has been collected and deposited in the office of the Council.

THE widespread invasion and persistent devastations of locusts in so many parts of Africa give interest to all trials and experiments, as well as the ordinary remedies, employed for the alleviation of this ruinous plague of the farmer. The following notes from Mr. W. C. Robbins, Stock Inspector of the Lower Tugela and Mapumulo Districts, are published in the Cape official *Agricultural Journal*:—"For the past three days I have been over the ground where my men have been infecting locusts with Government fungus, and the result was that I found dead locusts everywhere. I send you a sample; you will notice they are full of worms, and we know from experience than when locusts are found in this state whole swarms die off. Some, you will see, are half eaten; these were eaten by their fellows. I have seen many clusters of locusts eating dead ones." The feeding upon bodies of dead locusts suggests that diseased locusts may be utilised as a substitute for locust fungus. Tests are being made to determine whether a preparation from diseased dead locusts will infect a swarm in the same way as locust fungus made in the Government laboratory.

IN a paper on "The Standardisation of Electrical Engineering Plant," published in the *Journal* of the Institution of Electrical Engineers, Mr. R. Percy Sellon arrives at the following general conclusions:—(*a*) Standardisation to a greater degree than at present exists is in the interest of the manufacturer, as a means of facilitating repetition and production, and of meeting the competition of standardising foreign manufacturers. (*b*) Standardisation of "ends" or "performance" as distinct from "means" or "constructional details" is equally in the interest of the user, by securing for him low purchase cost, prompt delivery, freedom from the risks of experimental designs, and full manufacturers' guarantees. (*c*) The relative absence of standardisation in Great Britain, in contrast with other countries, is mainly traceable to the prevailing system wherein the user's engineer specifies "means" or "constructional" details instead of confining himself to "ends" or "performance." (*d*) The determination of standards by organised effort rather than by the slow and costly process of "trial and error" is desirable, and should be undertaken under the auspices of the Institution of Electrical Engineers, as representing the interests of both producer and user.

IF standardisation is important for the electrical engineer, it is none the less urgently needed in connection with scientific literature. Although the pages of a large number of journals and transactions, both in this country and on the Continent, are of uniform sizes, both quarto and octavo, this is by no means the universal rule; and proceedings, especially of local societies in remote districts, as well as the more popular class of scientific journals, show almost every possible variation in the dimensions of their pages. We have before us a pile of such publications, arranged in order of size, and increasing gradually from 7 × 4½ inches at the top to 12 × 10 inches at the bottom. They include many papers which it is desirable to bind up with other literature on the same subjects, but which have had to be relegated to "the pile" on account of their inconvenient sizes. This is the more unfortunate because journals of this particular character often contain reports on current research, the inclusion of which in bound volumes of reprints, easy of reference, might often save those repetitions of investigations which involve much loss of time, and only lead to disappointment, accompanied by unpleasant—not to say undignified—controversies as to priority.

THE U.S. Department of Agriculture has issued a Bulletin, No. 74, containing "Organisation Lists of the Agricultural Colleges and Experiment Stations in the United States, with a list of Agricultural Experiment Stations in Foreign Countries." Thirty-six pages are occupied by notes on the courses of study and the names of the boards of instruction at fifty-nine colleges exclusively devoted to agricultural teaching, or with agricultural departments; while twenty-one pages give the names of the governing board and staff at fifty-six experiment stations. Then follows a list of foreign experiment stations, with the names of the directors, to which is added a most useful statement of the more important publications issued in 1899 by the various stations of the United States. Some notes on the relationship of the colleges and stations to the United States Treasury complete this exhaustive record. Probably, the information, so far as it concerns the United States, is trustworthy, but the same cannot be said in regard to the British stations, for this section of the work is defective alike as regards accuracy and completeness. It would be well to have the British section thoroughly revised in any future issue.

WE have received from Dr. W. van Bemmelen a memoir on the deviation of the magnetic needle from the end of the fifteenth century to the year 1750, with isogonic charts for the epochs 1500, and subsequent half centuries down to 1700. The work is published as a supplement to vol. xxi. of the "Batavia Meteorological and Magnetical Observations," and is the outcome of researches made during several years in various libraries and archives in the Netherlands and other European countries prior to the author's appointment to the Batavia Observatory. The work is a laborious compilation of all the most trustworthy observations, commencing with the voyage of Columbus in 1492, and is a most valuable contribution to terrestrial magnetism, containing between five and six thousand observations in all parts of the world, with references to the positions and the sources whence the information has been obtained. The value of the work is much enhanced by numerous critical remarks and by explanatory text; the language used is German.

As attention has recently been much directed to the enormous drafts that are being made on the coal supply of the world for power purposes, the following description of one of the most recent attempts to obtain power by utilising the hitherto wasted resources of nature may be of interest. A company called the Saint Lawrence Power Company, composed of English and American shareholders, some time since obtained a tract of 2000 acres of land at Massena, adjacent to the Saint Lawrence and Grasse rivers. On this land an electrical installation of considerable magnitude is in course of construction. The works, which it is expected will be completed next autumn, are intended to develop ultimately 110,000 horse-power. The plant is situated on the River Grasse, a tributary of the Saint Lawrence, from which the water for driving the machinery will be diverted through a canal three miles long, 200 feet wide at the bottom, and 25 feet deep. The bottom of this canal at the river end will be 60 feet above the ordinary water-level in the River Grasse, which will form the tail-race for the turbines. The preliminary mechanical equipment will be eight units of 5000 horse-power, each obtained by three twin turbines and dynamos. The land adjacent to the works which is to be utilised for manufacturing and allied purposes will be accessible by branches of the New York Central Railway and by the canal to the Saint Lawrence, which will be large enough to take vessels of considerable draught.

THE means of overcoming the difference of level of the country through which canals pass is in most cases overcome by locks placed either singly or in flights, depending on the height to be overcome. About twenty-five years ago, the locks between the Trent and Mersey Canal and the River Weaver, where there is a difference of 50 feet, were superseded by the hydraulic lift at Anderton. The boats here are floated into iron troughs which are raised or lowered by hydraulic power, one boat ascending and another descending at the same time. This system was subsequently adopted on other canals in France and Belgium, and, with some modifications, in Germany. What is claimed as an improvement on this system is now being carried out on the Erie Canal in America, at Lockport, by what is termed a "Pneumatic Balance Canal Lock." A description of this lift was given in a paper contributed to the Franklin Institute by Mr. Chauncey N. Dutton. The existing stone locks were erected in 1836, and overcame a lift of 62½ feet by means of five flights. The lock which is being erected to supersede these consists of two steel chambers, one for ascending and the other for descending boats. These chambers are divided into two parts, the upper one containing water to receive the boats, and provided with gates, as in the case of the Anderton lift; and beneath this a second chamber containing compressed air on which the lock-chamber floats. The air-chambers are so proportioned that they automatically differentiate the air-pressure. The water in the lock-chamber which contains the boat at the upper level is so adjusted that its weight, with the boat it contains, is 200 tons greater than that of the lower one. Each of these locks weighs 1500 tons and contains 4500 tons of water, the weight in motion, when the boats are ascending and descending, exceeding 12,000 tons. The advantages claimed by the use of compressed air are a saving in cost, safety in working, and great economy in water. The power for compressing the air is furnished by a 36-inch turbine working a four-cylinder pump. This also drives the dynamos which operate the gates and light the lift.

A RECENT report by Prof. Le Neve Foster upon the number of persons employed, and the number of fatal accidents, in mines and quarries in the United Kingdom, shows that in 1899 the death-rate of the workers at mines under the Coal Mines Act, taking underground and surface workers as a whole, was 1·26, whilst that of 1898 was 1·28. At the mines under the Metalliferous Mines Act, the death-rate of the underground and surface workers as a whole was 1·59, a figure decidedly higher than that of 1898, which was only ·96. The inside workers in quarries had a slightly smaller death-rate from accidents in 1899 than they had in the previous year.

A RECENT consular report (No. 2418) on the trade of Corsica states that of the few industries at present carried on, that of extracting tannic acid from chestnut wood is now perhaps the most flourishing in the island. This industry is carried on in Bastia, which is the commercial centre of Corsica, by two large factories which export together about 4000 tons of extract per annum, in concentrated liquid form. To prepare this quantity requires nearly 20,000 tons of wood of the sweet chestnut tree yearly. The immense forests are equal to supplying the demand for many years; but this tree not being under the control of the Administration of Woods and Forests its wholesale destruction without compulsory replanting will, it is feared, in time not only influence adversely the climate of large districts, but cause much misery in those districts where chestnut flour forms the staple food of the peasants. It is prepared from the dried fruit of the sweet chestnut.

ACCORDING to the Acting British Consul at Samoa, rubber has been introduced there, and is being grown by several of the planters. It appears to thrive, and as far as can be seen the soil is admirably adapted for the growth of this most valuable product.

WE have received the official edition of the Fourth Annual Report of the New York Zoological Society, the substance of which is given in more popular form in a publication alluded to a short time ago in our "Notes" column.

THE Marlborough College Natural History Society, in its *Report* for 1899, sets an admirable example to institutions of this nature in publishing a list of the Lepidoptera of the district, the elaboration of which has been a work of years. It is by the thorough working out of local faunas that provincial natural history societies can alone properly justify their existence.

REFERRING to a remark in the review of the "Vertebrate Fauna of the Shetland Islands" in NATURE of May 24 (p. 75), Mr. Eagle Clarke writes to say that though he revised some of the proofs, the revision of the Cetaceans was undertaken by Mr. James Simpson, and that he did not revise either the MS. or the proof relating to that order. "Mr. Simpson, who had a special knowledge of the group, has passed from among us, but I have little doubt that his inclusion of the Narwhal in the *Physeteridae* was the result of a mere slip."

THE *Entomologist* for June contains the first instalment of the translation of an article by Prof. Max Standfuss on experiments in hybridisation, and on the influence of temperature on the development of the Lepidoptera. As an instance of the line of investigation followed, we may quote the case of the map-butterfly (*Vanessa levana*), in which the difference between insects bred from the summer and winter pupæ is so great as to have formerly led to the belief that they belonged to different species. By placing the summer pupæ in an ice-house the winter imago was produced; but, on the other hand, it was found much more difficult to change by warmth the winter pupæ into the summer imago. This led to the inference that the winter form was the original one; and this is confirmed by the circumstance that the only near relatives of this insect are four species from northern Asia.

THE second edition, revised and largely rewritten, of Dr. Julius Wiesner's work, "Die Rohstoffe des Pflanzenreiches," is in course of publication by the firm of W. Engelmann, Leipzig; and the second and third parts have just appeared. The work will be completed in two volumes, and will probably be completed towards the end of this year.

A NEW edition of Thompson's "Gardener's Assistant," which has for many years been accepted as a trustworthy repository of information on the science and art of gardening in all its branches, is in course of publication by the Gresham Publishing Company. The work has been completely revised and entirely remodelled under the direction and general editorship of Mr. William Watson, of the Royal Gardens, Kew, and contains contributions by many eminent horticulturists. The first volume has just been published.

THE first volume of a "Cyclopedia of American Horticulture"—a work described as "comprising suggestions for cultivation of horticultural crops, and descriptions of the trade species of fruits, vegetables, flowers, and ornamental plants, together with geographical data and biographical sketches," has just been published by Messrs. Macmillan and Co., Ltd. It is edited by Prof. L. H. Bailey, whose fertility in the production of excellent botanical books is really astonishing, assisted by Mr. W. Miller. The present volume extends from A to D, and contains 509 pages and 743 illustrations. The work will be completed in four volumes.

A COMPLETE and convenient cabinet of glass-blowing apparatus and materials, arranged especially for students or others using Mr. T. Bolas's book on "Glass Blowing," has been put on the market by the Camera Construction Company. Exercises in the manipulation of glass cultivate delicacy of touch and perception, and are therefore excellent as manual training for young people. In scientific work, and more especially in physical and chemical sciences, the ability to work glass is a very valuable accomplishment, and a cabinet which provides a ready means of obtaining practice in this art is a desirable possession for laboratories as well as private students.

THE question as to whether strontium and barium can replace calcium in plants has been made the subject of inquiry by more than one experimenter. The February number of the *Bulletin* of the College of Agriculture of Tōkyō contains an interesting contribution to this question by Dr. U. Suzuki. Experiments were carried out with several species of plants and in soils containing varying amounts of calcium. The results show that strontium and barium can never replace calcium in phanerogams, as they are strongly poisonous, although the poisonous action may be lessened to a certain extent by the addition of lime salts. The *Bulletin* also contains papers by the same author on arginin, and its formation in coniferous plants; and by K. Asō, on the chemical composition of the spores of *Aspergillus Oryzae.*

AMONGST the products of the action of fluorine upon sulphur recently investigated by M. H. Moissan (see NATURE, April 19, vol. lxi. p. 597), thionyl fluoride, SOF_2, the existence of which was first indicated by M. Meslans, was noticed. MM. Moissan and Lebeau have now made this fluoride the subject of a more detailed study, and have succeeded in obtaining it in a pure state by two different methods—by the action of fluorine upon thionyl chloride, and by the interaction of fluoride of arsenic upon thionyl chloride. Thionyl chloride is a colourless gas, fuming slightly in moist air, and possessing an unpleasant odour resembling carbonyl chloride. It is easily condensed by a mixture of solid carbon dioxide and acetone, giving a liquid boiling at $-32°$. In the absence of moisture, glass is not attacked by the gas at temperatures below 400° C.; above this temperature silicon tetrafluoride and sulphur dioxide are produced. Water decomposes thionyl fluoride slowly at ordinary temperatures, giving hydrofluoric and sulphurous acid. Indications were obtained of another oxyfluoride of sulphur, not absorbed by water and possessing a much lower boiling point.

THE additions to the Zoological Society's Gardens during the past week include two Wild Swine (*Sus scrofa*, ♀ ♀), European, presented by the Lord Carnegie; three Chaplain Crows (*Corvus capellanus*) from Southern Persia, presented by Mr. B. T. Ffinch; a Herring Gull (*Larus argentatus*), European, presented by Mr. J. W. Berry; two Red Howlers (*Mycetes seniculus*, ♂ ♀) from Colombia, a Great Kangaroo (*Macropus giganteus*, ♂) from Australia, an American Flying Squirrel (*Sciuropterus volucella*), three American Box Tortoises (*Cistudo carolina*), a North American Trionyx (*Trionyx ferox*), three Changeable Tree Frogs (*Hyla versicolor*) from North America, a Black Sternothere (*Sternothoerus niger*) from West Africa, two Greek Tortoises (*Testudo graeco*), South European; six Argentine Tortoises (*Testudo argentina*) from the Argentine Republic, a Red and Yellow Macaw (*Ara chloroptera*) from South America, two Black-headed Caiques (*Caica melanocephala*) from Demerara, a Chough (*Pyrrhocorax graculus*), British, deposited; two Brown Mynahs (*Acridotheres fuscus*) from India, a Brown Mock Thrush (*Harporhynchus rufus*) from North America, an Occipital Blue Pie (*Urocissa occipitalis*) from the Western Himalayas, purchased; two Thars (*Capra jemlaicus*), five Swinhoe's Pheasants (*Euplocamus swinhoii*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHIC OBSERVATION OF EROS.—A circular from the Centralstelle at Kiel furnishes particulars of the photograph of the planet Eros obtained by Prof. Howe, of Denver Observatory, U.S.A., during the recent total eclipse. The position determined was:—

R.A.	23h. 47m. 3·9s.	1900 May 27·9129.
Decl.	+ 2° 46′ 33″	Greenwich Mean Time.

OCCULTATION OF SATURN.—There will be an occultation of Saturn by the moon on Wednesday evening, June 13, the particulars of which are as follows:—

	Sidereal Time. h. m.	Mean Time. h. m.	Angle from North Point. °	Angle from Vertex. °
Disappearance	15 7	9 40	89	116
Appearance	16 19	10 52	265	283

The planet rises about 8.55 p.m., so that the conditions for observation will not be very favourable.

HARVARD COLLEGE OBSERVATORY.—In *Circular* No. 50 issued from the Harvard College Observatory, Prof. E. C. Pickering reviews the methods adopted in the measurement of photographic light intensities. Since 1887 all the photographs obtained at the Observatory have had the image of a standard light impressed upon them for comparison. The methods now adopted have been developed by Mr. E. S. King, under whose direction the photographs are taken at Cambridge, and his description of the plan followed occupies the greater part of the circular. All sources of light, that of the sun, moon, sky, Milky Way, aurora and stars are to be referred to one standard, given by the meridian photometer, with which Polaris has a magnitude of 2·15. The artificial standard for practical convenience is that given by an Argand burner behind a small aperture; but this is compared with Polaris every month, when a series of tests are made on a 8 × 10 in. plate, the various parts of which are then cut and stored for future inspection. These monthly comparisons in addition furnish a valuable check on the constancy of the plate and the developer used, and will, moreover, as the several parts of the divided plate are developed at different periods, furnish data concerning any change in the image dependent on the interval between exposure and development. Spectroscopic photometry is also adopted to record the photographic intensity in terms of light of a particular wavelength.

Prof. W. H. Pickering has evolved a method of reducing the standard of comparison to the actual radiation received from a certain star shining directly on the plate. This unit, however, being so small, secondary and tertiary standards have been made from it by using lenses of known aperture and focal length. Thus, with a simple plano-convex lens of 8·2 cm. aperture, the image of α Ursæ Minoris was received on a piece of ground glass placed 3 cm. from the photographic plate. The "sensitive tint" was produced after twenty minutes' exposure, and the intensity of the light was calculated to be thirty times greater than the direct radiation from the star. For lights of great intensity this secondary standard is still too small, and then recourse is had to the Argand burner constant.

LIVERPOOL OBSERVATORY.—We have received the report of Mr. W. E. Plummer, the director of the Liverpool Observatory at Bidston, Birkenhead, on the work done in the year 1899. Although the seismograph has not been in use all the year, it is intended to commence keeping a continuous record of earth movements by means of the present instrument and one to be supplied by the Earthquake Committee of the British Association. The two will be placed so as to record movements in planes at right angles to each other.

The report contains detailed results of all meteorological observations during the year, including temperature, barometric pressure, rainfall, sunshine and cloud, wind velocity, humidity, &c.; and an appendix is added containing a summary of the mean values of many of these quantities during the past thirty years.

TEMPERATURE CONTROL OF SPECTROGRAPH.—In the *Astro-Physical Journal* (vol. xi. pp. 259–261, 1900), Prof. W. W. Campbell describes the arrangement he has finally adopted for securing as complete uniformity as possible of the temperature of the various parts of the spectrograph used at the Lick Observatory for determining stellar velocities in the line of sight. The whole instrument is first enclosed in two thicknesses of thick grey blanket, the prism case having an additional two thicknesses over it. Outside the whole is then fitted a case of cedar, lined with felt, in which is embedded a length of German silver wire. This latter is heated by an electric current, the strength of which is so regulated that a thermometer placed in the prism box shows as constant reading as possible. The efficiency of the device is clearly shown by a table giving the actual variations observed during a night's work. From 8.28 p.m. to 4 a.m. the temperature of the air in the dome varied from 17°·2 C. to 19°·0 C., but the extreme readings of the thermometer in the prism box were only 18°·70 C. and 18·84° C., so that the maximum variation was less than one-fifth of a degree.

ADVANCEMENT OF ELECTRICAL CHEMISTRY.

IN a previous article (March 1, p. 428) upon the advancement of electrical chemistry, various developments of electro-metallurgy or electrical deposition of metals were described. Electrolytic processes for obtaining the non-metallic elements and for the preparation of inorganic and organic compounds were left for consideration in a separate article, and are now dealt with.

In the year 1800, Nicholson and Carlisle showed that water could be decomposed into oxygen and hydrogen by means of a "volta pile"; since that time the electrolytic decomposition of water has been employed as a lecture experiment to show the composition of water. It is, however, only quite recently that oxygen and hydrogen have been produced on a manufacturing scale by the electrolysis of dilute solutions of caustic soda or sulphuric acid. The hydrogen so obtained is usually almost absolutely pure, but the oxygen is generally mixed with about 3 per cent. of hydrogen, which, however, can be removed by passing it through red-hot tubes.

The powerful oxidising action of ozone has through the advancement of electrical science been pressed into the service of the manufacturer. The methods employed for its production are all more or less based upon the well-known Siemen's tube. Generally speaking, air and not oxygen is ozonised, the air to be ozonised being freed from dust and from excess of moisture, the last of which causes formation of hydrogen peroxide. The temperature should be kept as low as possible, because at low temperatures oxides of nitrogen are less liable to be formed and the quantity of atmospheric oxygen converted into ozone is increased; indeed, some manufacturers cool the air down to 4° C. before subjecting it to the electric discharge. For convenience of use the ozone is generally compressed into iron cylinders under a pressure of from four to five atmospheres. It is used for refining and bleaching linseed and palm oils, and for the manufacture of oxidised oil for linoleum. Brewers are often troubled with fouling of the beer barrels; this seems to be due to the growth of a fungus which often penetrates the wood to a considerable depth, so that ordinary methods of cleansing fail to remove it. The oxidising action of ozone has been successfully employed to remove this growth, the method being to alternately steam and ozonise the casks. It has also been utilised to remove fusel oil from alcohol, in the purifying of water, the refining of sugar in place of animal charcoal, and in a great variety of other manufacturing processes.

It is well known that synthetical diamonds have been obtained by means of the electric furnace; charcoal obtained from sugar is rammed into a wrought iron cylinder, which is then closed with a plug. The cylinder so filled is placed in a bath of molten iron kept at a high temperature in an electric furnace, after which the crucible which contains the iron is rapidly cooled by immersion in melted lead. On dissolving the iron in acid minute diamonds are obtained. It was a question whether here we had a case of simple crystallisation of the carbon from the molten metal on cooling, or whether the enormous pressure which was exerted upon the interior of the mass by the rapid cooling of the outside acting upon the carbon at a high temperature caused the formation of crystals of diamond. An exceedingly ingenious experiment which has been carried out by Majorana shows that at any rate the influence of high pressure and high temperature combined is sufficient to convert amorphous carbon into the crystalline variety. Majorana's experiment is as follows:—

A cylindrical chamber, A (Fig. 1), is hermetically closed at the top by a solid block of iron, E, the bottom by a solid piston, S. The sides of the chamber are made of tempered steel, and to further strengthen it the chamber is surrounded by fifteen iron rings 1 cm. thick, which are bolted together. The whole system is placed within an hexagonal frame, K, also made from iron plates. The piston, S, has a small solid iron cylinder about 1 cm. in diameter attached to it, at the end of which is fastened a small piece of carbon, C, about 2 grms. in weight. Directly below the piston a thick block of iron, *p*, is fixed, into which a hole exactly the size of the small end of the cylinder has been drilled. In carrying out the experiment the carbon is heated by means of the two carbon poles, D, D′, with a current of 25 amperes and 100 volts. When the carbon has become white-hot, 70 grms. of gunpowder contained in the chamber A is exploded, the piston being driven down, carrying the heated carbon before it and compressing it with enormous force. On taking the system to pieces the carbon is found to have been partially converted into microscopic diamonds, which when freed from unchanged amorphous carbon are found to possess all the characteristics of natural diamonds.

Reference has already been made to the importance of the manufacture of calcium carbide; another carbide, that of silicon, is now being manufactured in considerable quantities, and, owing to its extreme hardness, is being employed in place of emery for polishing steel and making grindstones. This carbide, which goes under the name of "carborundum," is manufactured by means of the electric furnace. An American company at Niagara Falls employs furnaces capable of dealing with ten tons of material, consisting of coke, sand, common salt and sawdust, which yield two tons of carborundum in twenty-four hours. In the first half of the year 1897 it is stated that in America alone 750,000 lbs. of carborundum were manufactured. Since the introduction of electricity to chemistry the carbides of almost all the metals have been obtained, the majority naturally being more of theoretical than of commercial interest.

From the days of Leblanc, the founder of the soda industry, perhaps no branch of inorganic chemistry has been more worked at, or has better shown the results of patient toil and inventive genius, than the alkali and bleaching industry. Only after many attempts and many failures has the seemingly simple task of electrolysing sodium and potassium chloride yielded results

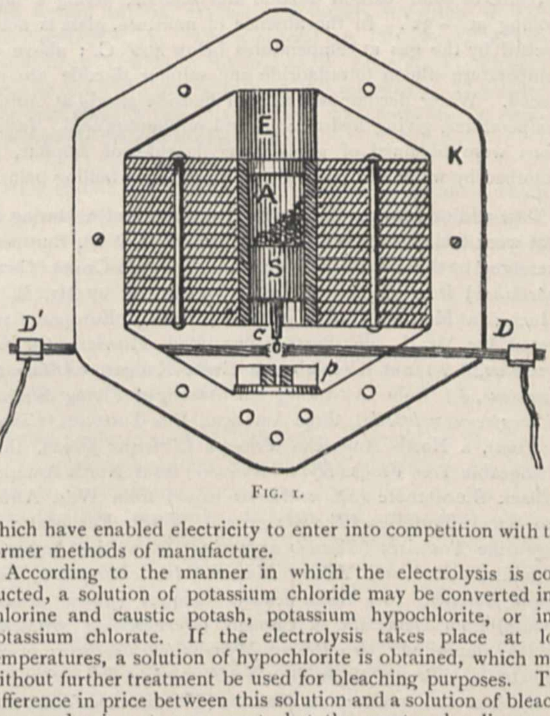

FIG. 1.

which have enabled electricity to enter into competition with the former methods of manufacture.

According to the manner in which the electrolysis is conducted, a solution of potassium chloride may be converted into chlorine and caustic potash, potassium hypochlorite, or into potassium chlorate. If the electrolysis takes place at low temperatures, a solution of hypochlorite is obtained, which may without further treatment be used for bleaching purposes. The difference in price between this solution and a solution of bleaching powder is not very great, but the greater cleanliness and purer bleaching action of potassium (sodium) hypochlorite make it, when electric power can be easily obtained, at least a powerful competitor with bleaching powder. When the electrolysis is conducted at temperatures from 60° and upwards, the bath being kept slightly alkaline by addition of potassium bicarbonate or lime, potassium chlorate is produced, which, owing to its slight solubility in water, crystallises out, and by washing is readily freed from adhering chloride.

If caustic potash and chlorine are required, some arrangement must be made to prevent the liberated chlorine from again reacting with the caustic potash formed at the same time. Formerly, and still to a small extent, this was arranged by means of a diaphragm which separated the anode from the kathode. Owing, however, to the difficulty of obtaining a *pervious impervious* diaphragm, *i.e.* one which allows the current to pass, but is impervious to the solution, it is now more general to electrolyse without a diaphragm. The method employed is one which was originally employed by Castner and

Kellner, the kathode being a layer of mercury at the bottom of the bath. On the current being passed, the potassium liberated at the kathode dissolves in it, forming an amalgam, which as it is formed is drawn off and run into pure water, the water being decomposed, assisted by an auxiliary current, with evolution of hydrogen and formation of caustic potash, which is obtained in the pure condition by evaporation. Carbonate of potash may be prepared by passing a stream of carbonic acid gas into the caustic liquors before evaporation. In commerce, naturally, it is more general to electrolyse the cheaper sodium chloride, at any rate, in this country. Strontium and barium chlorate are also manufactured by electrolysis of their chlorides.

It has been found possible to prepare painters' colours by electrolysis, *e.g.* "white lead" is obtained in a very pure condition by electrolysing a dilute solution of sodium chlorate and carbonate, the electrodes being of lead. If the sodium carbonate is replaced by sodium chromate, a neutral lead chromate is produced, an acid chromate being formed by cautious addition of a solution of chromic acid during the electrolysis.

To attempt to mention, much less to describe, the enormous number of inorganic compounds and elements which have been prepared or isolated by the aid of electricity, would be, in an article such as this, impossible; but sufficient examples have been given to show the importance of electrical processes in this branch of chemistry.

Turning now to organic chemistry, we notice that, although a vast amount of work has been done, it is more of theoretical interest than of technical value. But now that the initial difficulties have been to a large extent overcome, and the manner in which the reactions take place is better understood, it is probable that shortly this branch of manufacturing chemistry will also undergo a revolution in the hand of the electro-chemist. As a means of synthesis and of proving the formula of substances, electrolysis has been, and is, of great value to the organic chemist. Thus on electrolysing a solution of an alkaline acetate, ethane is produced; whereas by employment of a succinate, ethylene is formed, a solution of fumaric acid yielding acetylene. These are, of course, simple cases; but even that seemingly unsolvable problem, the constitution of camphoric acid, has been attacked by Walker, and by means of electrolysis of it and its derivatives he has obtained results which must be of great value in ultimately deciding what is the correct formula for this substance.

Iodoform can now be produced in a state of great purity by electrolysing a solution of potassium iodide and sodium carbonate to which alcohol has been added. On electrolysis, employing electrodes of platinum, iodine is continually set free at the anode, and coming in contact with the alcohol at the moment of its liberation produces iodoform. As the reaction proceeds some of the iodine becomes converted into hydriodic acid, and this combines with the alkali liberated at the kathode, or which has been added to the bath, potassium iodide being regenerated, which by the further passage of the current is again split up. The process is a continuous one, the iodoform being from time to time removed and a further quantity of alcohol, potassium iodide and sodium carbonate added. It is interesting to note that the alcohol cannot be replaced by acetone, as in this case only a very small quantity of iodoform is produced. Chloroform and bromoform have not been successfully prepared by this method. Chloral can, however, be produced by electrolysis of a solution of potassium chloride at 100°, to which alcohol is from time to time added.

By the electrolysis of nitrobenzene in a strongly acid alcoholic solution, aniline is produced. If the nitrobenzene is suspended in concentrated hydrochloric acid, ortho- and para-chloraniline are formed. By electrolysis under other conditions, azobenzene, hydrazobenzene or azoxybenzene are obtained.

By the electrolytic oxidation of aniline, dye products can be obtained the nature of which depends upon the solution employed, the strength of the current and the material of the electrode, *e.g.* if an aqueous solution of aniline hydrochloride, which may be either acidified with sulphuric acid or be practically neutral, is electrolysed, platinum electrodes being employed, a green precipitate is produced at the anode, which becomes violet, bluish-violet and finally almost black, practically the theoretical quantity of aniline black having been formed. If the aniline contain toluidine, then mauveaniline, rosaniline, &c., are produced.

Attempts have been made to obtain alizarine by electrolysis of anthraquinone in strong alkaline solution; indeed, small quantities are said to have been obtained.

It has even been found possible to utilise electricity in the dyeing of cloth. When, *e.g.* a piece of cloth is soaked in a solution of aniline sulphate and placed between two metal plates, which are connected with opposite ends of a dynamo, and the current passed, the aniline sulphate is converted into aniline black; indeed, by altering the strength of the solution and the density of the current, shades varying from green to deepest black can be produced.

In the case of indigo the cloth is thoroughly impregnated with a thin paste of indigo-blue and caustic alkali; it is then placed between two metal electrodes. On the current being passed, the insoluble indigo-blue is converted by reduction into the soluble indigo-white, which on exposing the cloth to the action of air becomes again oxidised and the material dyed blue. Patterns may be printed on the cloth by cutting or stamping the plates in relief, or by connecting one pole to a metal plate and the other to a metallic pencil, when patterns, &c., can be readily sketched upon the material (Goppelsroeder).

Such processes as have been described in these articles appear, when seen in print, as extremely simple. Theoretically they may be so; but in practice, the carrying out of these seemingly simple operations is often attended by great difficulties. For example, the temperature must not be allowed to rise too high or fall too low. The quantity of current and its potential require often to be kept within extremely narrow limits, as the following simple example illustrates.

Silver and copper can be separated by means of electrolysis, the silver alone being deposited if a very low current density (·10 ampere) is employed, whereas with a higher density (·50–1·0 ampere) the copper is deposited. Naturally, then, if at the commencement of the operation the higher current density is employed, both metals will be deposited together. Many of the difficulties to be overcome are to a large extent engineering. And it is to a considerable extent due to collaboration of chemists and engineers that the science of electro-chemistry has become what it is.

Electro-chemistry is quite in its childhood, but it is making marvellous and rapid progress. Works dealing with technical chemistry but a few years old require to be revised, owing to the alterations which this branch of chemical industry has brought about.

It is humiliating to realise that in this country there is hardly a book on the subject to be obtained, and in most cases even these are only translations from Continental works. And it is to be feared that unless this branch of chemistry becomes more studied than it has been up to the present, we shall find in the near future that electro-chemistry, both theoretical and practical, is the property of America and the Continent.

F. MOLLWO PERKIN.

ROAD LOCOMOTION.[1]

THE author commenced by saying that the subject of mechanical propulsion upon common roads had now reached a point when it deserves the very careful consideration of mechanical engineers.

For many years the uses and importance of the traction engine have become more and more recognised, but its work covers only a portion of the field for mechanical propulsion on roads, and he went on to consider what has led to a general revival of a movement for lighter road-locomotives which about seventy years ago, in the days of Hancock and Gurney, reached a point that for a time appeared to be leading to permanent results of the most important kind, but which ended in complete failure. In one sense this revival is undoubtedly due to the passing of the Locomotives on Highways Act in 1896, previous to which, for more than twenty years, a law had existed which made it impossible for any self-propelled vehicle to proceed at a rate of more than four miles an hour. The immediate cause of the passing of this Act was the attention aroused in this country by the successful introduction of the motor vehicle for purposes of pleasure in France. The real causes of the present movement were probably to be traced to the gradual feeling amongst all classes of the community that modes of transport, both for purposes of pleasure and business, on the roads had not kept pace, or indeed had made little progress at all, compared with the great changes which had been effected

[1] Abstract of a paper read before the Institution of Mechanical Engineers by Prof. Hele-Shaw, F.R.S., April 26.

in speed, comfort and convenience, in the direction of locomotion by rail.

The author went on to consider at some length the question of the conveyance of goods, and by means of a graphical diagram showed that up to forty miles motor vehicles, owing to the terminal charges, might compete with railways. The hygienic question and growing difficulties of traffic in large cities was next touched upon. Next the difficulties of the problem were considered, and it was shown that these difficulties were very great; and so far from the success of the railway system being an argument in favour of the immediate development of locomotion by road, the conditions of the problem were such as to involve improvement exactly in the opposite direction to that in which the railway locomotive has been successfully developed.

No doubt the progress of invention would enable a greater amount of power from a given weight of motor to be obtained; but the surface to be moved over, which is the real difficulty of the road locomotive, would remain the chief factor of the problem.

The first section of the paper was therefore devoted to the mechanical problem of the behaviour of the wheel upon the road, and the progress which has been made in this direction.

Under this head the whole question of resistance upon the road was treated, and the author made a strong point of the fact that there was very little data available for determining resistance upon roads at the high speeds now permissible, and with different kinds of tyres now in use. He gave diagrams of horse-power curves of resistance adapted to English measures from the "Tableaux Numerique et Graphique" of MM. Boramé and Julien, and a series of graphical results taken with the Viagraph of Mr. Brown, showing the nature of the shocks to a vehicle by roads of macadam, stone, asphalte and wood.

The subject of pneumatic tyres was then discussed, and also the question of wheels suitable for heavy traffic, and illustrations of a number of improved types of wheels for this purpose, which had been invented during the last year or so, were given. With any existing system in which four wheels are used, it was shown that the problem of road locomotion was difficult because of the concentration of the load upon such a limited area of support. Even for heavy traffic the pneumatic tyre might come into use in the future as it extends the area of resistence by yielding, so that the surface in contact is much greater than in the case of an iron-rimmed wheel, especially when running over stone sets or hard ground.

Beyond this, it is quite conceivable that, just as in railways the number of wheels has been largely increased until a modern bogie carriage has commonly twelve wheels supporting it, it may be found economical to support a motor vehicle also upon a much greater number than at present.

The steering of motor vehicles, which was the subject of the next section of the paper, is evidently a very important part in their design, and it may at once be said that with one or two exceptions the great majority of motor vehicles are steered upon the principle which was invented by Ackermann as long ago as 1818. The essential principle of the Ackermann system consists in replacing the pivoted fore carriage of an ordinary vehicle which has one axle for the two wheels, by two short pivoted axles each carrying one of the steering wheels. The conditions of correct running of the wheels are that when their plane is turned, their normals intersect on a point on the line of the axles of the driving wheels. The paper then went on to describe the various modifications of the Ackermann system.

The next section of the paper was devoted to a consideration of motive power and its transmission to the wheels, and under this head the particular uses and advantages of oil, steam and electricity were considered; although these various agencies have at the present moment fairly well recognised spheres of operation this must be by no means regarded as the final condition of things, or as giving a limitation to the employment of each of these types of motive power. Thus, although at present oil-engines are used for light motor vehicles and steam for heavy traffic, there are very ingenious steam motor-cars both in this country and abroad, while light oil-engines have been applied in France and also in this country in connection with heavy traffic.

Oil-engines, or internal-combustion engines, have by a process of the survival of the fittest been found so far best suited for light motors and pleasure vehicles. The cycle of the gas-engine is really complex, but these motors have been brought to a high state of perfection, so that upon being started they are found to work for long distances without any attention. If really well designed and constructed, and used with a moderate amount of care, they need little repairs or adjustment, while the objection of smell, vibration, and danger from the use of light petroleum spirit with a low flash point, have all been much reduced, while each year sees an increasing number of places in town and country where petroleum spirit can be obtained. Still the objections above-mentioned must be admitted to exist, and this, together with the great expense of pleasure vehicles, has to a certain extent hitherto prevented their introduction becoming general. Again, an oil-engine, which has little elasticity in regard to an increased demand for power when ascending a hill, requires elaborate gearing for change of speed, which may be after a time, if not at first when the car is new, a very noisy and objectionable feature. Heavy-oil engines for internal combustion have been tried for motor vehicles, but the difficulties of starting and smell have not yet been satisfactorily overcome.

Steam, or external-combustion motors, require not only a generator or boiler, but also a condenser, in addition to the steam-engine itself. The latter is not used with all motors, but in winter the cloud of steam which must be visible in damp cold weather at a little distance from the exhaust, even if the steam is superheated, really contravenes the Act, which states, "No smoke or visible vapour must be emitted, except from any temporary or accidental cause." Steam introduces a more complicated array of pipes and fittings, and requires more attention and skill in working, but it is highly probable that such improvements will be made in connection with steam motors, that no skilled attendant will be necessary. There is already at least one steam system which is entirely automatic, whilst others are to a great extent so. It is not too early to speak as to the practical and commercial success of any of the systems using steam, but if a condensing steam-engine, automatic in action, with a boiler which is perfectly safe from any fear of explosion, can be produced, it may safely be predicted that there is a great future before it, both for light and heavy traffic, as it would have the advantages of great power and elasticity, freedom from smell, and if using heavy oil, or even coal or coke, would be free from the danger and trouble incidental on the employment of light oil, especially abroad. Moreover, the ease with which a steam motor can be started and stopped, and more particularly reversed, cannot be over-estimated.

Fuels, other than coal, coke or oil, have been the matter of careful consideration by motor-car designers. The most promising of these is acetylene, which, as derived from calcium carbide, enables a much greater quantity of energy to be obtained from a given weight of fuel; but although it only requires one-fourth of the weight of calcium carbide to produce a given amount of work as compared with coke, the expense at present makes its use commercially impossible.

Electrical motors are clean, extremely convenient and simple, free from all vibration and danger and altogether an ideal type of motor. The limitations in the use of electricity are, however, very serious, and are discussed later in the paper.

The details of internal combustion motors are discussed under the six headings upon which their success more or less depends, viz.: (1) carburisation, (2) ignition, (3) starting, (4) governing, (5) balancing, and (6) cooling.

The subject of steam is then treated at considerable length, and types of the more important steam heavy motor vehicles, such as those of Thorneycroft, Simpson and Bodman, Musker, Coulthard, Bayley and Clarkson and Capel are given, together with various examples of water-tube and flash boilers, which may be said to be the two types of boilers specially suitable for motor vehicles on account of their high steaming capacity in proportion to their small weight.

In considering the actual results which have been obtained by motor vehicles, a distinction is made between pleasure vehicles and those for the conveyance of goods. For the former, the actual cost of working is not by any means the first consideration; in a large number of cases, in fact, the cost is comparatively of small importance. Questions of comfort, durability and safety, as well as freedom from liability to break down, are the chief points to be considered. These matters can scarcely be summed up except as the result of lengthy experience, and now undoubtedly that experience is gradually being acquired.

When we come to the question of goods traffic, the matter is of course entirely one of cost, including not merely the outlay, working and upkeep, but deterioration, which in road vehicles is exceptionally heavy. Extended trials of actual working are necessary for any final opinion of the relative merits of different types of heavy motor vehicles, and the author has fortunately been able to secure much valuable testimony of this sort on the subject.

A great deal, however, can be ascertained by careful trials, such as those which have been undertaken on two occasions at Liverpool (1898 and 1899), since measurements and data can be obtained with a staff of observers for a limited period, which could scarcely be secured in continuous working. The results of these trials are given in tables and also statements by the Chief Mechanical Engineer of the Lancashire and Yorkshire Railway, on the working of a Thornycroft motor wagon; the Engineer-in-Chief, Mersey Docks and Harbour Board; and the City Engineer of Liverpool, on the working of Leyland motor wagons; and by Mr. Bryan Donkin, on the tests of motor carriages at Richmond and Birmingham.

Looking at the whole question, it may be safely said that the motor vehicle has come to stay, and that its uses, both in peace and war, will rapidly and enormously develop. The public interest which is now seen partly by the immense number of patents taken out in connection with the industry, partly by the great growth of literature on the subject, and by the formation of automotor clubs, is not a mere transient thing, and although the motor vehicle is at present still somewhat of a *rara avis* upon our roads, it may not be going too far to think that the coming century will see a development of locomotion upon roads comparable with the development of locomotion of the railway in the century which, according to our individual views of chronology, is either past or so very nearly past.

THE UNIVERSITY OF BIRMINGHAM.

THE present position of the scheme for the establishment of a Midland University was explained by Mr. Chamberlain, Chancellor of the new University, at the first meeting of the Court of Governors, held on Thursday last. In the course of his remarks, Mr. Chamberlain is reported by the *Times* to have said that it was desired to create a great teaching University, in which all who came to them for it should find efficient and complete instruction in every branch of knowledge. Again, they desired that their University should be a school of research. They were firmly convinced that that was necessary if it was to maintain its dignity and great position. They believed that those were the best teachers who were themselves constantly learning, and that without adding continuously to the common stock of knowledge they would not be fulfilling their duties. In order to secure those objects they ventured to ask for a further endowment of a quarter of a million sterling. To-day they were able to announce that they had already received promises of 330,000*l*., the amount having been largely increased by the munificent donations of Mr. Carnegie, of an anonymous benefactor, of Mr. Charles Solcroft, and of Mr. George Kenrick.

They intended that their University should be a distinctive University. In what he had hitherto indicated there was nothing original, nothing in which they were likely to specially differentiate themselves from the other great Universities, especially from the modern Universities in this country and the older Universities of Scotland; but they hoped that their University would take some colour from its environment, that not only would it be a school of general culture, but that it would also practically assist the prosperity and welfare of the district in which it was situated by the exceptional attention which it would give to the teaching of science in connection with its application to local industries and manufactures; and this portion of their task had turned out to be much greater, much more responsible, than they anticipated. They were encouraged in undertaking it by the gift of Mr. Carnegie, which was specially to be devoted to the creation of a college of science, following somewhat the example which had been set by the great colleges in the United States of America; and Mr. Carnegie followed this up by a proposal that a deputation from the intended University should visit the chief seats of learning across the water.

Those who had read the report of the committee that had visited Canada and the United States would begin to understand how it was that we were behindhand in the preparation for that great struggle which must come, that commercial competition between nations in which the weakest would inevitably go to the wall. For what did they find established both in the United States and in our own colony of Canada? They found great institutions connected with a general University, with colleges of science occupying large spaces, in which the area was counted by many acres, fully equipped with proper buildings, with the most modern and complete machinery, with the latest scientific appliances, with laboratories for every conceivable scientific purpose; and in those great colleges a training was given such as they desired to see imitated in this country—a training based, as all education ought to be, upon a foundation of general culture, but specialised in its course, highly specialised according to particular and separate work which each student intended to undertake in life. As a result of this they began to see how it was that in America the great commercial and industrial undertakings, the manufacturers and inventors, found no difficulty whatever in obtaining the services of as many young men as they might require to manage and complete and develop their undertakings, all of them ready when they left college, not merely to deal with the ordinary routine and management of a business, but to bring to it the latest discoveries and to apply the highest science to its development. That was what they wanted in Birmingham, and they would not have the University which they all had in their minds until they had accomplished it.

All that was wanted was money. The committee had pointed out that to carry out this scheme with any completeness a further sum, partly for endowment, partly for buildings and machinery and appliances, of 155,000*l*. was required. He was quite convinced, even from an incomplete examination of the project, that they had under-estimated the cost. He thought himself that another quarter of a million was the smallest sum which they would require in order to put this portion of their undertaking upon a thoroughly satisfactory basis. Well, they must get it, and he anticipated that they would obtain it. He anticipated that they would obtain it from two sources. Nothing he thought was more striking to any one who had studied educational progress in America and in our great colonies than the readiness, the eagerness, with which men who had acquired great wealth had been willing to devote a considerable portion of it in sums to which we here, he was sorry to say, were almost unaccustomed, to the promotion of the higher education. It was the case in Canada, in the great Universities of Montreal and Toronto; it was the case in America, in Cornell, in the Stamford University, in the Chicago University, in the Columbia University; and it was also visible in the great donations which had been made to the older Universities of Harvard and of Yale. He could not doubt that the feeling that no better application than this could be found for wealth would grow among them about Birmingham, and that although they lived in a district which had hitherto not been remarkable for exceptional fortunes, yet which did contain many men of great wealth. They also would find a tendency, from which the University would derive advantage in the future, to make their contributions towards such purposes as he had described. He hoped that this might be the case, and he thought he might say that he had confidence that it would be the case, and they might expect before long that their funds would be largely increased from some such source.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Chawner, Master of Emmanuel College, has been re-elected Vice-Chancellor.

Mr. Frederick Harrison will deliver the Rede Lecture in the Senate House on June 12, at noon. The honorary degrees referred to last week will be conferred on the same day, at 3 p.m.

The Knightbridge Professorship is vacant by the resignation of Dr. Sidgwick, who has been seriously ill.

Mr. L. R. Wilberforce, of Trinity College, has been elected a University Lecturer in Experimental Physics in the place of Mr. W. N. Shaw.

A grant of 50*l*. from the Balfour Fund has been made to Mr. J. S. Budgett in aid of his researches on the development of Polypterus.

Dr. Allbutt and Dr. Collingridge have been appointed delegates to represent the University at the International Congress of Hygiene and Demography to be held at Paris next August.

THE 500th anniversary of the foundation of the University of Cracow will be celebrated to-day, June 7. Representatives will be present from most of the European universities.

MR. W. T. A. EMTAGE, principal of the Wandsworth Technical Institute, has been appointed Director of Public Instruction in Mauritius. The post has been newly created, and Mr. Emtage will have the oversight of all the educational work under Government in the Colony. His first task will be the organisation of a system of technical education.

AT University College, London, Andrews Entrance Scholarships of 30*l*. each have been awarded to Mr. L. Graham, of Mason College, Birmingham, and to Mr. C. E. K. Mees, of St. Dunstan's College, Catford. The Atchison Scholarship of 55*l*. per annum for two years has been awarded to Mr. R. E. Lloyd for the greatest proficiency as a student of the medical faculty and the hospital during the past two years. The Bruce medal has also been awarded to Mr. R. E. Lloyd for proficiency in pathology and surgery.

THE Senate of the University of London has resolved that one sum of 100*l*. be offered as the Rogers Prize open for competition to all the members of the medical profession in Great Britain and Ireland, for an essay upon the production of immunity in specific infective diseases generally; and with particular reference to any one disease on which the writer of the essay has made original investigations. The essay is to be sent to the Registrar, University of London, South Kensington, S.W., on or before June 1, 1901.

THE Yorkshire College, Leeds, is now one of the university centres that grant a degree to students of agriculture. At a meeting of the Court of Victoria University (on May 3) a report of the Council recommending the inclusion of agriculture as a subject for the B.Sc. degree was adopted. Among other requirements, the scheme provides that students before taking their degree must conduct at an experimental farm controlled by a College of the University an experiment on some agricultural subject, and submit a report of the same. Only those students who, before entering the University, have attended an agricultural school for two years will be exempted from this rule.

AN illustrated prospectus of the courses of chemistry and chemical engineering at the Massachusetts Institute of Technology has recently been received. The prospectus includes descriptions of the various chemical laboratories, and the accompanying illustration of the main laboratory of industrial chemistry is of interest as indicating the provision made, in one of the foremost technical institutions in the United States, for work by students taking a general course in chemical industries. The ordinary course in chemistry in the Institute extends over a period of four years, and embraces almost all branches of chemical science. The aim throughout the whole course of instruction is not only to impart the necessary professional knowledge, but also to teach the student self-reliance, to accustom him to habits of accurate thought and work, and to instuct him in the methods of investigation of new problems. The course is designed primarily to prepare students for actual work in connection with manufactures based on chemical principles, but it provides also for those who expect to become teachers of chemistry, and for those who intend to devote themselves to scientific research. The object of the instruction in industrial chemistry is to set before the students as fully as possible the present status of the chemical industries. The laboratory instruction includes the preparation of pure chemicals, and the refinement or purification of technical products, by industrial processes. Among the processes carried out in the laboratory are the manufacture of dyers' mordants, soaps, phosphates from bone ash, and soda crystals; and also the preparation of salts of ammonium, barium, calcium, iron, copper, tin, chromium, &c., from minerals or other crude material. In addition, about eighty lectures are given on the most important industrial processes, and excursions are frequently made to manufacturing establishments.

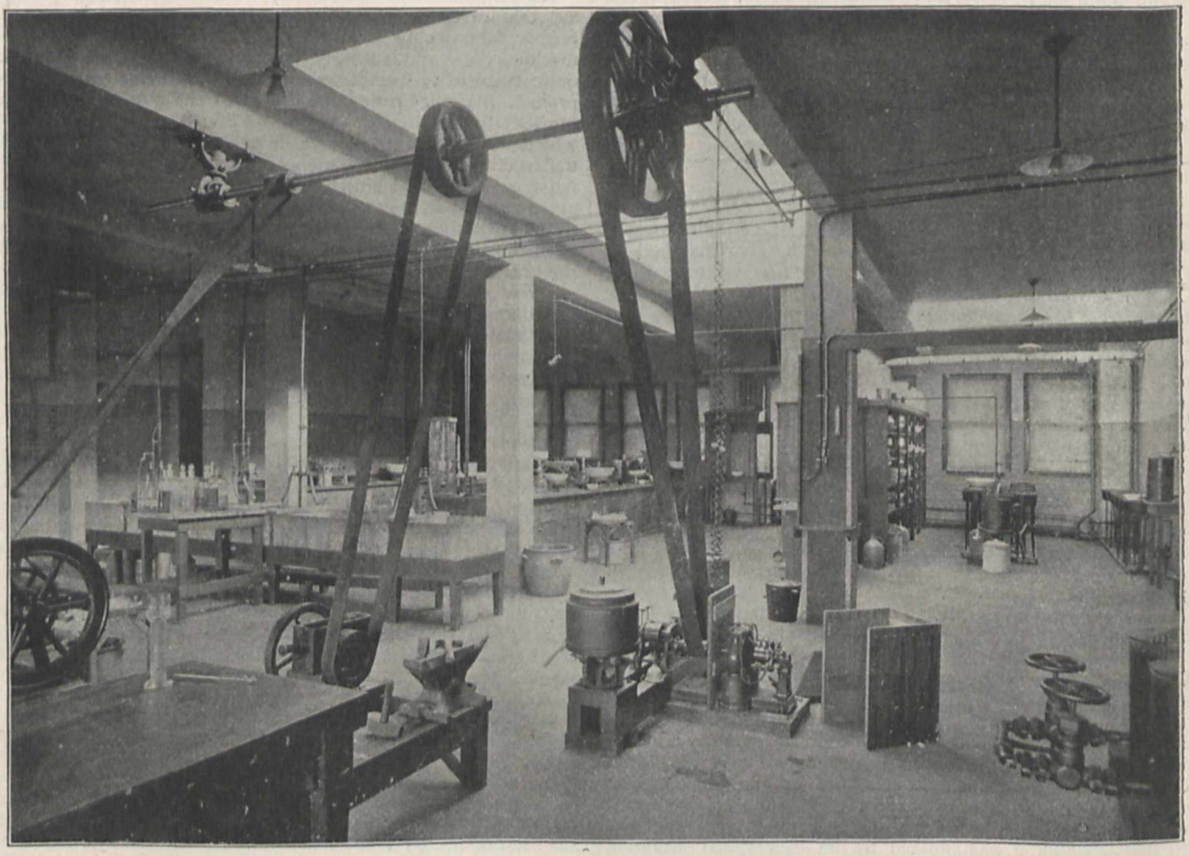

FIG. 1.—Laboratory of Industrial Chemistry of the Massachusetts Institute of Technology.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, May 17.—Prof. Thorpe, President, in the chair.—The following papers were read:—The chlorine derivatives of pyridine. VI. The constitution of some amino-chloropyridines, by W. J. Sell and F. W. Dootson.—Ortho-substituted nitrogen chlorides and bromides, and the entrance of halogen into the ortho-position in the transformation of nitrogen chlorides, by F. D. Chattaway and K. J. P. Orton. When phenylacetyl nitrogen chloride undergoes transformation, a mixture of 95 to 96 per cent. of para- with 4 to 5 per cent. of ortho-chloroacetanilide is produced.—Ammonium imidosulphite, by E. Divers and M. Ogawa. A crystalline ammonium imidosulphite, $NH(SO_2NH_4)_2$ is obtained on allowing ammonium amidosulphite to decompose below 35° in a current of hydrogen or nitrogen.—The constitution of ethyl sodiocyanacetate and of ethyl methylsodiocyanacetate, by J. F. Thorpe. The reactions of ethyl sodiocyanacetate and of ethyl methylsodiocyanacetate are best represented by the formulæ CN.CH:C(ONa)OEt and CN.CMe:C(ONa)OEt respectively.—The $\alpha\alpha_1\beta\beta$-tetramethylglutaric acids, by J. F. Thorpe and W. J. Young. Ethyl sodiocyanacetate reacts with ethereal iodine solution, yielding ethyl iodocyanacetate, and under certain conditions gives an unstable diiodide which reacts with the excess of ethyl sodiocyanacetate giving ethylic dicyanosuccinate,

$$\begin{array}{l} CH(CN).CO_2Et \\ | \\ CH(CN)\cdot CO_2Et \end{array}$$

. Ethyl methylsodiocyanacetate reacts with iodine, forming ethyl methyliodocyanacetate which condenses with ethyl dimethylacrylate, giving the salt $CO_2H.CH(CN).CMe_2.CHMe.CO_2Et$; the latter on distillation gives ethyl α-methyl-$\beta\beta$-dimethyl-γ-cyanobutyrate,

$$CH_2(CN).CMe_2.CHMe.CO_2Et,$$

and this when hydrolysed yields $\alpha\beta\beta$-trimethylglutaric acid. The preparation of *cis*- and *trans*-$\alpha\beta\beta\alpha_1$-tetramethylglutaric acid is also described.—β-Isopropylglutaric acid and the *cis*- and *trans*-methylisopropylglutaric acids, by F. H. Howles, J. F. Thorpe and W. Udall.—Methyl iodide acts on the sodio-derivative of the product resulting from the condensation of ethyl sodiocyanacetate with ethyl β-isopropylacrylate, yielding ethyl α-cyano-α-methyl-β-isopropylglutarate. The latter on hydrolysis yields ultimately *trans*-α-methyl-β-isopropylglutaric acid and its imide; the imide is converted into the *cis*-acid by heating with sulphuric acid.—The racemisation of optically active tin compounds. Dextromethylethylpropyl tin dextrobromocamphorsulphonate, by W. J. Pope and S. J. Peachey. Optically inactive methylethylpropyl tin iodide is wholly converted into dextromethylethylpropyl tin dextrobromocamphorsulphonate by treatment with the silver salt of the acid and evaporating the filtered solution; the new salt has the molecular rotatory power $[M]_D = +318°$ in dilute aqueous solution, but after heating and cooling the solution the value $[M]_D$ falls to $+273°$, which is the value $[M]_D$ of the acid in aqueous solution. After evaporating the solution to dryness and making up to the original volume by dissolving the residue in cold water, the value $[M]_D = +315°$ was obtained. It is thus proved that the asymmetric tin radicle

$$(CH_3)(C_2H_5)(C_3H_7)Sn-$$

can be easily racemised and easily converted into one optically active component.—Racemic and optically active forms of isoamarine, by H. L. Snape. The author has resolved optically inactive isoamarine into its optically active components by crystallising its tartrate; the dextro-base has the specific rotatory power $[\alpha]_D = +62{\cdot}02°$. The crystals of the optically active bases are orthorhombic and sphenoidally hemihedral.

Linnean Society, May 3.—Mr. C. B. Clarke, F.R.S., Vice-President, in the chair.—Mr. H. E. Smedley exhibited a number of botanical wax models prepared on an enlarged scale to show the morphological structure and also the process of reproduction in various types of plants.—Mr. J. E. Harting exhibited and made remarks on some skins of willow grouse collected by Prince Demidoff on the N.W. border of Mongolia between Alta Mountains and the Kobdo River.—On behalf of Miss E. S. Barton, the Botanical Secretary read a paper on a new species of *Halimeda* from Funafuti; and on behalf of Miss A. L. Smith, a paper on some West Indian fungi, with descriptions of a new genus and species.

May 24. Anniversary Meeting.—Dr. A. Günther, F.R.S., President, in the chair.—The following were elected into the Council:—Mr. Clement Reid, Dr. D. H. Scott, Rev. T. R. R. Stebbing, Prof. S. H. Vines, and Mr. A. Smith Woodward; and as President, Prof. Sydney Howard Vines, F.R.S.; Treasurer, Mr. Frank Crisp; Secretaries, Mr. B. Daydon Jackson and Prof. G. B. Howes, F.R.S.—The retiring President then delivered his annual address, choosing for his subject, "The unpublished correspondence of William Swainson with contemporary naturalists (1806–1840)," lately acquired by the Society.—The Gold Medal of the Society was then presented to Prof. Alfred Newton, F.R.S., in recognition of his important contributions to zoological science.

Royal Microscopical Society, May 16.—Mr. Carruthers, F.R.S., President, in the chair.—Mr. Chas. Baker exhibited two microscopes; one made specially for critical work was fitted with eye-pieces of the Society's new Standard gauge, No. 3, of 1·27 in. The other instrument, named the "Plantation" microscope, was designed for use in the tropics for the purpose of discovering the ova of internal parasites. Dr. Hebb said a paper had been received from Mr. Millett, being Part viii. of his report on the Foraminifera of the Malay Archipelago. This, as on former occasions, would be taken as read.—E. M. Nelson read a paper on the lag in microscopic vision, which he illustrated by diagrams and a series of tables showing the proportionate values of the performance of various objectives under eye-pieces of different powers. In the case of an apochromatic objective of fine quality, the degree of merit was shown to range from 14·7 with a low eye-piece, to 7·7 with a deep one, but the difference was more marked with ordinary dry achromatic lenses. Mr. Nelson's experiments had shown that in respect to the lag, microscopes with short tubes had some advantage over those with long tubes. Mr. Nelson also read a paper, for Mr. E. B. Stringer, on a new form of fine adjustment, a microscope by Messrs. Watson and Son, fitted with the arrangement, being exhibited. Mr. Nelson said that its working seemed exceedingly good. As the fine adjustment was placed just behind the body, the limb could be made of any length without putting additional strain upon the screw, a matter which would be of great advantage in microscopes made for examining large sections.—In announcing the adjournment of the meeting until Wednesday, June 20, the president said he hoped then to be able to submit and explain a series of lantern slides representing minute structure of some Palæozoic plants.

PARIS.

Academy of Sciences, May 28.—M. Maurice Lévy in the chair.—Formation of nitric acid in combustions, by M. Berthelot. When sulphur is burnt in the calorimetric bomb in compressed oxygen under a pressure of twenty-five atmospheres, some nitrogen also being present, nitric acid is formed in quantities amounting to about ·001 of the sulphur present. At atmospheric pressure the amount of nitric acid formed is much reduced. With metals such as iron and zinc no nitric acid is formed.—Preparation, properties and analysis of thionyl fluoride, by MM. H. Moissan and P. Lebeau (see p. 137).—On the laws of specific heats of fluids, by M. E. H. Amagat. The formula $\frac{dC}{dp} = -AT\frac{d^2v}{dt^2}$ is applied to find the relation between the specific heat and pressure of carbon d oxide. The values o $\frac{dv}{dt}$ and $\frac{d^2v}{dt^2}$ were found graphically from the experimental data, and the results are given in the form of curves.—On some remarkable sub-groups of a group of substitutions or transformations of Lie, by M. Edmond Maillet.—On partial differential equations of the third order which admit of an intermediate integral, by M. A. Guldberg.—Formulæ giving the volumes of saturated vapour and the maximum pressure, by M. H. Moulin. The formulæ deduced from theoretical considerations by the author are compared with the experimental data of Young, Tate and Amagat for benzene, fluorbenzene, carbon tetrachloride, ether, acetic acid, methyl alcohol, water and carbon dioxide with satisfactory results.—The energy absorbed by condensers submitted to a sinusoidal difference of potential, by MM. H. Pellat and F. Beaulard.—The transparency of some liquids for electrostatc oscillations by M. A. de Heen.—On some photochemical effects produced by the wire radiating Hertzian waves, by M. Thomas Tommasina.—On a lithium peroxide, by M. de Forcrand. Since the combustion of lithium in oxygen gives only traces of a peroxide, attempts were made to prepare lithium peroxide in the wet way, by the action of hydrogen peroxide upon solutions of lithium salts. A thermochemical study of the products showed that some Li_2O_2 is formed in this way.—On the unknown earths contained in crude samaria, by M. Eug. Demarçay. The oxide isolated contains neither samarium nor gadolinium, and is of an atomic weight between these two elements. The chief lines of the spark and absorption spectrum are described.—The reduction of erythrulose and the preparation of a new erythrite, *d*-erythrite, by M. Gabriel Bertrand. Ordinary erythrite is easily oxidised by the sorbose bacterium to the ketone erythrulose,

$$CH_2(OH).CO.CH(OH).CH_2OH,$$

and this on treatment with sodium amalgam gives a mixture of two erythrites, one identical with the original inactive erythrite, the other, separated by means of its acetal, is active, possessing a rotatory power $[\alpha]_D = -4^\circ{\cdot}76$.—Action of cyanogen chloride upon acetone-dicarboxylic ethyl ester, by M. Juvénal Derôme. The cyano-derivative produced,

$$(CO_2C_2H_5).CH.CN.CH_2(CO_2C_2H_5),$$

readily forms metallic salts, the hydrogen adjacent to the cyanogen group being replaced.—On the metallic combinations of diphenylcarbazone, by M. P. Cazeneuve.—Osmotic pressure of the egg and experimental polyembryony, by M. E. Bataillon. —On the sub-fossil Lemuridæ of Madagascar, by M. Guillaume Grandidier.—On the discovery of a cave containing animal remains at Bains-Romains, near Algiers, by MM. E. Ficheur and A. Brives. The remains found include the bones of the species *Bubalus*, *Bos*, *Cervus*, *Antilope*, *Hippopotamus*, *Rhinoceros* and *Equus*. The presence of man was indicated by a molar, flint heads, and the presence of calcined bones.—Mode of action of antileucocytic serums upon the coagulation of the blood, by M. C. Delezenne. The mode of action appears to be identical with that of a peptone, the intravenous injection of a leucolytic agent being the same in all cases, the destruction of the white corpuscles circulating in the blood.—On the restoration to life obtained by the rhythmical compression of the heart, by MM. Tuffier and Hallion. A claim for priority against M. Batelli.

DIARY OF SOCIETIES.

THURSDAY, JUNE 7.

LINNEAN SOCIETY, at 8.—On a Viviparous Syllid Worm: E. S. Goodrich. —On the Genera Phæoneuron, Gilg., and Dicellandra, Hook f.: Dr. A. Itapf.—On the Structure and Affinities of *Echiurus unicinctus*: Miss Embleton.

CHEMICAL SOCIETY, at 8.—Diphenyl- and Dialphyl-ethylenediamines, their Nitro-derivatives, Nitrates, and Mercurochlorides: W. S. Mills. —Condensation of Ethyl Acetylenedicarboxylate with Bases and β-ketonic Esters: Dr. S. Ruhemann and H. E. Stapleton.—The Constitution of Pilocarpine: Dr. H. A. D. Jowett.—The Nitrogen Chlorides derivable from *m*-Chloroacetanilide and their Transformations: Dr. F. D. Chattaway, Dr. K. J. P. Orton, and W. H. Hurtley.—Derivatives of Cyanocamphor and Homocamphoronic Acid: Dr. A. Lapworth.

RÖNTGEN SOCIETY (St. Bartholomew's Hospital), at 8.—Dr. Lewis Jones will show an Influence Machine of American design.—Mr. James Wimshurst, F.R.S., will give a short statement of his work in the design and the perfecting of the several forms of his Influence Machine.—Dr. Rémy, of Paris, will show a new Localising Apparatus.

FRIDAY, JUNE 8.

ROYAL INSTITUTION, at 9.—The Effect of Physical Agents on Bacterial Life: Dr. Allan Macfadyen.

PHYSICAL SOCIETY, at 5.—On the Magnetic Properties of Iron and Aluminium Alloys, Part II.: Dr. S. W. Richardson.—Note on Crystallisation produced in Solid Metal by Pressure: W. Campbell.—On the Viscosity of Mixtures of Liquids and of Solutions: Dr. C. H. Lees.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Note on a Meteoric Shower South of Corvus: W. F. Denning.—Theory of the Motion of the Moon, Part III. Chapter vi.: Ernest W. Brown.—The Solar Eclipse of 1900 May 28 observed at Stonyhurst: Rev. W. Sidgreaves.—The Solar Eclipse of 1900 May 28 observed at Norwich: G. J. Newbegin.—The Total Solar Eclipse of 1900 May 28 observed at Navalmoral, Spain: Rev. S. J. Johnson.—*Probable Papers:* Description of the Durham Almucantar: R. A. Sampson.—The Cause of the Shadow Bands seen in connection with Total Eclipses of the Sun: G. Johnstone Stoney.

MALACOLOGICAL SOCIETY, at 8.—Note on Two Apparently Undescribed Species of *Bensonia*: W. T. Blanford.—The Non-marine Mollusca of Norfolk Island: E. R. Sykes.—Among the Exhibitions will be Specimens of *Volutilithes abyssicola*, *Eburna papillaris*, and *Bullia annulata* from South Africa, also *Cypræa nigricans*, together with other New Caledonian Cowries: G. B. Sowerby.—Dissections of the Genitalia of *Acavus*: W. B. Randles.

MONDAY, JUNE 11.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Maintenance of Aëration as a Standard of Purity of Sewage Effluents: W. J. Dibbin and G. Thudichum.—The Composition and Determination of Cerium Oxalate: Dr. Frederick B. Power and Frank Shedden.—The Production of Nitrate of Soda in Chili: F. G. Welch.

TUESDAY, JUNE 12.

ANTHROPOLOGICAL INSTITUTE, at 8.30.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Construction of Photographic Objectives: Mathematical Investigation: H. L. Aldis.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—*Probable Papers:* Some New Observations on the Static Diffusion of Gases and Liquids, and their Significance in certain Natural Processes occurring in Plants: H. T. Brown, F.R.S., and F. Escombe.—The Electrical Effects of Light upon Green Leaves (Preliminary Communication): Dr. A. D. Waller, F.R.S.—The Exact Histological Localisation of the Visual Area of the Human Cerebral Cortex: Dr. J. S. Bolton.—The Diffusion of Ions produced in Air by the Action of a Radio-active Substance, Ultra-violet Light and Point Discharges: J. S. Townsend.—Data for the Problem of Evolution in Man. V. On the Correlation between Duration of Life and the Number of Offspring: Miss M. Beeton, G. U. Yule, and Prof. K. Pearson, F.R.S.—On an Artificial Retina and a Theory of Vision, Part I.: Prof. J. C. Bose.

MATHEMATICAL SOCIETY, at 5.30.—Some Multiform Solutions of the Partial Differential Equations of Physical Mathematics and their Applications, Part ii.: H. S. Carslaw.—Some Quadrature Formulæ: W. F. Sheppard.—Notes on Concomitants of Binary Quantics: Prof. Elliott, F.R.S.—Extensions of the Riemann-Roch Theorem in Plane Geometry: Dr. Macaulay.—On the Invariants of a certain Differential Expression connected with the Theory of Geodesics: J. E. Campbell.—On the Constants which occur in the Differentiation of Theta Functions: Rev. M. M. U. Wilkinson.

CONTENTS.