THURSDAY, AUGUST 12, 1909.

ASIATIC PALMS.

Annals of the Royal Botanic Garden, Calcutta, Vol. xi. Asiatic Palms—Lepidocaryeæ. Part i., The Species of Calamus. By Odoardo Beccari. Pp. iii+518; 2 4to plates; 238 plates large fol. (Calcutta: Bengal Secretariat Press, 1908.) Price 7*l*.

THE palms of Asia have received considerable attention in the Royal Botanic Garden at Calcutta, where there is an extensive Palmetum, with a noble collection of living species. Roxburgh, superintendent of the garden from 1793 to 1813, studied the palms of the Indian Peninsula, and left, in addition to descriptions posthumously published in his "Flora Indica," a series of drawings of the species he knew alive. Anderson, superintendent from 1861 to 1870, described the palms of Sikkim in the Journal of the Linnean Society, vol. xi., in 1869. Kurz, curator of the Calcutta herbarium from 1864 to 1878, dealt with the palms of Burma in the Journal of the Asiatic Society of Bengal, vol. xliii., part ii., in 1874. But the work of Roxburgh was only preliminary, the work of Anderson and Kurz only supplementary to that of Griffith, who acted as superintendent of the Calcutta garden during 1842–4. This able observer died at Malacca in 1845, and his treatise, "The Palms of British East India," was not printed until 1850. Less complete than he could have made it had he lived to see it through the press, this work by Griffith yet remained the standard authority on the subject until the appearance, in 1892, of the account of the Indian Palmeæ by Beccari and Hooker in the "Flora of British India," vol. vi. The long-standing association of the great Calcutta garden with the elucidation and illustration of Asiatic palms is now happily continued by the publication in its Annals of the first portion of a comprehensive account of the family by Signor Beccari, who dedicates his work to the memory of the gifted Griffith.

This volume commences the discussion of the tribe Lepidocaryeæ, palms the fruits of which are clad in a mail of reflexed, adpressed, closely imbricating scales, and deals with the genus Calamus, the largest and most important in that tribe. Workers who know these "Rotangs" as they grow are familiar with the difficulties that attend their study; those unacquainted with these fascinating but formidable "canes" in a wild state will learn something of these difficulties from the essay with which the volume opens. All will welcome a work on the subject by one whose knowledge of the species in the field is comparable with that of Griffith himself, and who has had the advantage, which was denied to Griffith, of access to practically all the herbarium material of the genus that exists.

The greater part of the letterpress is devoted to detailed accounts of the various species which the accompanying plates illustrate. Those who study these descriptions will be grateful to the author for the conscientious absence of uniformity in their presentation. Where his material is adequate, the author has provided full and carefully weighed statements of the specific characters; where his material is limited he has restricted himself to faithful accounts of the actual specimens on which his species are based. His work is thus free from that unconscious tendency to generalise more widely than the material at a writer's command will justify, which sometimes detracts from the value of treatises wherein the descriptions of species that depend on the study of perhaps a solitary example are cast in the same mould as those based on extensive suites of specimens. At the same time, he has shown himself fully alive to the advantages of methodical treatment, and, in a careful synopsis which immediately precedes his detailed descriptions, the author has characterised all the species he is able to recognise with sufficient fulness to admit of their determination, and in a manner that leaves nothing to be desired so far as uniformity of presentation is concerned.

In a systematic conspectus of the species, which follows the definition of the genus, the author has skilfully applied to the practical task of establishing order among what would otherwise be an undisciplined horde of forms that knowledge, at once comprehensive and minute, of the morphology of Calamus to which the introductory essay testifies. He is thereby able to throw his species into sixteen readily recognisable groups, some of which admit of further subdivision, while the whole of them are capable of aggregation into four series. One of these series, it is true, contains but a single group, the characters of which are admittedly anomalous, while the imperfect nature of the material as yet available renders it impossible, in the case of about 5 per cent. of the species, to state with certainty to what group they should be referred. But this conspectus will enable the worker in the field, whose needs should be the first consideration of conscientious systematists, to recognise with comparative ease at least the affinities of any "Rotang" he may encounter. The applied botanist, too, will feel indebted to the author for the many economic notes that accompany the detailed accounts of such species as are practically useful.

The plates which accompany the work are mainly phototype reproductions of the author's natural-size photographs of herbarium specimens; in a few cases, where the material available did not readily lend itself to this method, lithographed drawings take the place of phototypes. Photographic methods, though usually satisfactory so far as fidelity is concerned, when applied to the illustration of herbarium specimens often leave something to be desired from the æsthetic standpoint. Here, however, there is little ground for criticism on this score, and if it be true that specimens of Calamus lend themselves more readily to the requirements of photography than herbarium material usually does, this is not the whole explanation of the success that has here been achieved. That success is in large measure due to the care and skill of the author, who has, moreover, been fortunate in the matter of reproduction from his negatives, which

reflects much credit on those to whom it has been entrusted. The size of plate adopted, it may be observed, is that of the double plates issued in former volumes of the Calcutta Annals, so that librarians who desire to bind the illustrations in conformity with the text are left free to do so. But there will probably be others who may prefer to leave the plates unfolded, and the editor of the series has earned the gratitude of those into whose hands this volume may come for his decision to issue the illustrations in a larger portfolio than that which contains the letterpress, thereby leaving them free to decide the course to be adopted. The work before us is a valuable addition to the series of volumes for the initiation of which the scientific world is indebted to the late Sir George King, and botanists generally will not only feel grateful to Signor Beccari for its preparation, but will desire to associate themselves with him in his appreciation of that "enlightened munificence" on the part of the Government of Bengal which has rendered its appearance possible.

GYROSCOPIC MOTION.

An Elementary Treatment of the Theory of Spinning Tops and Gyroscopic Motion. By Harold Crabtree. Pp. xii+140 and 3 plates; with illustrations. (London, New York, Bombay, and Calcutta: Longmans, Green and Co., 1909.) Price 5*s.* 6*d.* net.

THIS enchanting and bewildering subject has in recent years been admirably expounded in two well-known books, one somewhat more severe in its treatment than the other. The author has now provided a third, which will be valued by those who already possess and take pleasure in the other two even more than by those who approach the subject for the first time. The mathematical treatment is far more severe, so much so that the average student who scoffs at the term elementary on the back of some of his text-books will certainly in this case consider it inconsistent with the subject-matter of the last few chapters. However, if he will afterwards read the subject in, say, the "Encyclopædia Britannica," he will realise that the term is not so misleading after all.

The method by which the theory is introduced is admirable. In an introductory chapter, illustrated by twenty-six figures, all sorts of tops and spinning things, familiar and otherwise, are described, and their curious behaviour in each case simply stated. An interest is thus awakened, and the reader, if unfamiliar with the subject, realises at once what sort of thing he is going to have presented to him. In the writer's opinion this method would be advantageous generally where a difficult subject is being opened. If, for instance, before the first chapter of the typical book on the integral calculus or before Euclid's definitions there were a lightly written chapter giving more or less familiar experiences which are puzzling, but which will in due time be made clear, the reader would be more encouraged than he is by the existing openings.

The author clears the ground by giving very exact ideas on the subject of rotation about a fixed axis, laying stress at every point on the dimensional identity of the two sides of every equation. In dealing with the subject of precession, he is by no means content to handle the ultimate condition of steady precession, but he goes fully into that more difficult subject which may be summarised under the term gyrostatic elasticity, and which includes the immediate displacements and vibrations or wobblings of axes when disturbing couples are applied or removed.

The latter part of the book is in large part devoted to the difficulties connected with the motions of the axis of rotation of an ellipsoidal body within itself and in space. Among matters of interest discussed will be found the behaviour of celts, the self-turning of a falling cat, with kinematograph views, the diabolo, the Brennan mono-rail, and Schlick's gyroscopic device for steadying ships.

While criticism is misplaced, the writer would suggest that those diagrams, such as Fig. 20, in which bent arrows are intended to show a direction of rotation round an axis indicated by a line, are, as drawn, ambiguous, for it is impossible to tell whether the arrow is intended to be in front of or behind the line. If one or other were broken through the meaning would be evident, as it is, for instance, in Fig. 18, where the arrow is clearly in front of a material axle.

C. V. Boys.

MAGIC SQUARES.

Easy Methods of Constructing the Various Types of Magic Squares and Magic Cubes, with Symmetric Designs founded Thereon. By Dr. John Willis. Pp. 256. (Bradford and London: Percy Lund, Humphries and Co., Ltd., 1909.)

A MAGIC square is an example of a problem which is a particular case of another which from its enunciation may be subjected to mathematical analysis. The n^2 cells of a square of order n may be supposed occupied, each of them, by one or more numbers in such wise that the sums of the numbers in the n rows and in the n columns have given values varying from row to row and from column to column. The enumeration of such squares, or more generally of such rectangles, has been made the subject of mathematical investigation employing algebraic symmetric functions and the allied differential operators, and complete success has resulted. The absolute magnitude of the numbers appearing in the cells may be restricted, and any number of the cells may be empty; no additional difficulties present themselves. Other problems of enumeration of the magic square kind, of which the simplest is known as the Latin square, first examined by Euler, and by others up to the time of Cayley, have also in recent years completely yielded to the same calculus of symmetric functions. In all these cases row and column properties are dealt with, but directly we introduce what may be termed diagonal properties the analysis fails to overcome the great difficulties which are thereby imported into the problems. The problem of the magic square involves restrictions and limitations of

the general problem above mentioned which render it impossible of complete treatment by any known method of analysis. The condition that the first n^2 natural numbers must appear one, and only one, in each cell, is, to begin with, of a most difficult character, and is made more so by the importation of the diagonal conditions. Many kinds of magic squares, moreover, involve additional properties connected with broken diagonals, nuclear squares, symmetrically placed cells, &c., which mathematically are of a most arduous nature. It thence arises that though many mathematicians of repute from the earliest times have studied the subject, they have devoted their labours mainly to observational and tentative methods of actually constructing different classes of these squares, and have seldom seriously attempted the enumeration.

Dr. Willis has put together in this work all the best-known methods of constructing the various types, and he gives a good idea of the magnitude of the numbers that may be reached when attempt at enumeration is made. There is one magic square of order 3, and 880 of order 4; beyond this huge numbers may be expected. As an illustration he takes the case of the "square of eight in magic quarters" (chapter viii.), and in forming an estimate he takes as unit the number of different squares which could be printed in a year; if this could be done at the rate of a million per second, by keeping the press at work day and night without ceasing during 365¼ days; his conclusion, "at a very moderate estimate," is that 150,000 years would be required. A particular kind of pernuclear square of order 20 is similarly shown to have a number of forms approximately given by 2953 followed by 135 zeros.

Chapter x., on magic cubes and geometric designs, takes the reader somewhat out of the beaten track, and will be found particularly interesting. In introducing the subject of magic designs, he says:—

"By making use of magic cubes in which the horizontal squares are magic . . . we may form a mosaic design which is magic in the sense that the n horizontal squares, from which the design is formed, may be found by inspection of the number of tesseræ of n different colours contained in each of the n^2 squares of which the complete design consists."

The author gives five examples of these beautiful patterns printed in colours. Anyone who will take the pains to master the method explained will find himself able to add to these to an unlimited extent, and probably possessed of the power of evolving new principles of mosaic design.

The late Prof. Sylvester was enthusiastic about mosaic designs based on mathematical principles, and one of his "anallagmatic squares," carried out in marble, was for many years in the hall of the United Service Club.

This book will be useful to the numerous persons who find the subject an amusement and recreation. The mathematical equipment required for its comprehension is limited to the multiplication table. The book is well and appropriately printed, and the different types used for both letters and numbers are of much assistance to the reader. P. A. M.

PHYSICAL CHEMISTRY.

Grundriss der allgemeinen Chemie. By Wilhelm Ostwald. Vierte, völlig umgearbeitete Auflage. Pp. ix+661. (Leipzig: W. Engelmann, 1909.) Price 20 marks.

TWENTY years have passed since the appearance of the original edition of "Ostwald's "Grundriss," in which the principles of modern physical chemistry were first competently placed before the general scientific public. From time to time new editions have appeared, but comparatively little change was made in the original form, the lines of development of physical chemistry having been determined by the work of van 't Hoff, Arrhenius, Nernst, and the author at a period immediately preceding the composition of the book.

The fourth edition, which is now before us, has in many respects been profoundly modified. The discovery of radio-activity and the investigation of gaseous ions give a new point of departure for chemical research and theorisation, and this the author has fully recognised in the present volume. It says much for his open-mindedness that he now relinquishes definitely and explicitly his former position that the existence of atoms and molecules received no cogent experimental proof from chemical or physical science. In his preface he writes:—

"Even the most cautious experimental man of science is now justified in speaking of the atomistic nature of extended matter—on the one hand by the isolation and enumeration of the gaseous ions, the crowning-point of the excellent and persevering work of J. J. Thomson; and on the other by the correspondence of the Brownian movements with the demands of the kinetic theory which has been shown to exist by a number of investigators, finally and most completely by J. Perrin."

With the further remark of the author that this, for him, new point of view should be first properly introduced in the chapters devoted to the results of these researches, one may be disposed to agree, in view of the real pedagogic danger of allowing the student to believe that the stoichiometric laws can only be valid owing to the existence of atoms, instead of being, as they are, generalisations from experiment, and independent of any hypothesis as to the constitution of matter. The author has, therefore, made only a subsidiary use of the atomic hypothesis in the earlier part of the work.

The volume is now subdivided into the following books:—i., substances; ii., stoichiometry; iii., chemical thermodynamics; iv., electrochemistry; v., microchemistry; vi., photochemistry; vii., chemical affinity.

Chemical kinetics and equilibrium receive treatment in book iii., colloidal solutions in book v., and radio-activity in book vi.

The author has made a deliberate attempt to meet the criticism that former editions of the book were too difficult for the ordinary scientific reader. The extreme compression and logical treatment aimed at certainly required an amount of concentration beyond that at the disposal of the student when he began the study of physical chemistry. It may be said at once that

the author has been very largely successful in his endeavour to adapt the subject to the comprehension of those to whom the book would be most useful. It is not even yet easy reading—it is doubtful if any thorough text-book of physical chemistry *can* be easy reading—but no intelligent advanced student of chemistry can neglect to peruse and ponder it if he wishes to be abreast of the latest developments of the theoretical side of his science in their actual and in their potential aspects. We learn with pleasure that an English translation of this important work is in course of preparation.

THE CHEMISTRY OF DRUGS.

(1) *Grundriss der Pharmakochemie.* By Dr. O. A. Oesterle. Pp. xii+562. (Berlin: Gebr. Borntraeger, 1909.) Price 17.50 marks.

(2) *Southall's Organic Materia Medica. A Handbook treating of the more important of the Animal and Vegetable Drugs made use of in Medicine, including the whole of those contained in the British Pharmacopoeia.* By J. Barclay. Seventh edition. Revised and enlarged by E. W. Mann. Pp. xx+376. (London: J. and A. Churchill, 1909.) Price 7*s.* 6*d.* net.

(1) DURING the past quarter of a century a steadily increasing amount of attention has been devoted to the study of crude drugs. The investigations of these have proceeded largely upon botanical lines, many researches having been published on the morphology and anatomy of vegetable drugs and the microscopical characters of their powders. The authors of modern text-books of pharmacognosy have, in most instances, confined themselves almost entirely to dealing with their subject from this point of view, and have been very niggardly in the treatment of the history, commerce, and chemistry of drugs. Great strides have, however, been made in the chemical investigation of the constituents of vegetable as well as animal drugs. The constitution of many has been satisfactorily elucidated, and not a few have been synthetically prepared. The literature of these investigations is, unfortunately, scattered in various journals and special publications, and every teacher of pharmacognosy will have experienced the difficulty of, as well as the necessity for, collecting such information, notwithstanding the useful works of Brühl, Pictet, van Rijn, Schmidt, Dekker, and others.

Prof. Oesterle's work appears, therefore, most opportunely. He deals with those crude organised vegetable drugs the constitution of the constituents of which has been more or less completely ascertained, but has excluded the resins and oleo-resins, as these have recently been exhaustively treated by his colleague, Prof. Tschirch. The individual drugs are grouped according to their characteristic constituents, a rational arrangement, since allied constituents commonly have similar therapeutic action, and it is for this that drugs are employed. The important constituents alone are considered, but they are considered very fully. The manner in which their constitution may be demonstrated, the successive stages in their decomposition, and the synthesis of the substance itself or of a characteristic decomposition-product are fully explained, though perhaps here and there speculation is somewhat in evidence. To the section of alkaloidal drugs 159 pages are devoted, to aromatic drugs 247, to glucosidal 46, to colouring matters 64, and to tannoids 12. Hence the second section has the lion's share, which, perhaps, is scarcely in accordance with its importance from the therapeutical point of view. To the constituents of opium 33 pages are devoted, to those of cinchona bark 19, while the consideration of menthone alone occupies 7.

Hydrastine may be selected as an example of the manner in which the constituents are treated. First the steps are shown by which hydrastine, by exhaustive methylation, is converted into hydrastonic and hemipinic acids, the constitutional formulæ, occupying three pages, being given; next the production of hydrastinine and opianic acid from hydrastine, and the conversion of hydrastinine into oxyhydrastinine and hydrastininic acid are shown together with the production from the latter of hydrastic acid and methylamine; then the action of caustic alkali upon hydrastinine resulting in the formation of hydrohydrastinine and oxyhydrastinine is explained, and finally the synthesis of hydrohydrastinine from piperonal and acetalamine.

A slight feeling of regret may be expressed that the author has confined himself to vegetable drugs, as those of animal origin contain several important constituents which have been isolated and examined.

Prof. Oesterle's work will be heartily welcomed by all who are interested in the constituents of drugs. It forms a unique contribution to scientific pharmacognosy, and will undoubtedly stimulate others to labour in a similar field.

(2) The fact that this work has now reached its seventh edition is sufficient testimony of the estimation in which it has been held, and the new issue, revised by Mr. Mann, who is well known for his contributions to the chemistry of drugs, will doubtless enjoy a similar popularity.

The general arrangement of the subject-matter remains the same, but increased attention has rightly been given to the chemical constituents of drugs, which have been dealt with, on the whole, in a very satisfactory manner, although here and there, as, for instance, the cyanogenetic glucosides of cherry-laurel leaves, wild cherry bark, &c., they have not been brought quite up to date. So far as the utility of the work from the point of view of the student is concerned, there are certainly two or three weak points. In the first place, the restriction of the description of official drugs to the characters given in the British Pharmacopœia has involved the omission of much that is important as well as interesting. Official descriptions of drugs are necessarily brief, and much that the student should observe and know concerning them is omitted. Details of the production, collection, preparation for the market, commerce, history, &c., are but meagre. Considerable help might have been

afforded by a few judiciously selected illustrations, but these the author considers undesirable.

The large number of drugs dealt with renders the book extremely valuable for reference, but the defects alluded to militate against its efficiency as an educational work for students. HENRY G. GREENISH.

MAGNETO- AND ELECTRIC-OPTICS.

(1) *Magneto- und Elektro-optik.* By Dr. Woldemar Voigt. Pp. xiv+396. (Leipzig: B. G. Teubner, 1908.) Price 14 marks.

(2) *Cours de Physique.* Cinquième Partie. Électroptique. Ondes Hertziennes. By Prof. H. Bouasse. Pp. 426. (Paris: Delagrave, n.d.) Price 14 francs.

(1) THIS is a work on one of the most fascinating branches of modern science by one of those who have done most towards its development. To all students of physics the volume is to be specially recommended as giving an admirable account of a subject which has the most intimate bearing on present theories of the constitution of matter; to those who are themselves working in the same field the name of the author will be sufficient to indicate that the book is indispensable.

The subject dealt with is not the electromagnetic theory of light in general, but, in Prof. Voigt's own words, "that special branch of optics which deals with the action of a magnetic or an electric field on the optical properties of bodies." The study of this special branch of optics may be said to have begun in 1845 with Faraday's experimental demonstration that the plane of polarisation of a beam of polarised light is rotated by the action of a magnetic field having its lines of force parallel to the direction in which the light is travelling. Since that date an enormous amount of attention has been given to the phenomena due to the action on light of a magnetic or an electric field. In 1876 Kerr succeeded in detecting the rotation of the plane of polarisation when light is reflected normally from the surface of a ferromagnetic metal in a strong magnetic field. In 1896 Zeemann showed that the periods of free vibration of the light emitted by a flowing gas are changed by the direct action of a magnetic field, and that there is a corresponding action on an absorbing medium. In 1898 Voigt himself showed that a body in a magnetic field becomes doubly refractive in the direction perpendicular to the lines of force, in the same manner as a uniaxial crystal perpendicular to its axis. In the section of electro-optics, the advances made are less marked. Kerr's demonstration that an isotropic insulating substance becomes doubly refractive in the direction perpendicular to the lines of electric force may be taken as fundamental. An army of workers has followed along the main lines thus indicated, and to-day the mere marshalling of the known facts of observation is a task of no small difficulty, while there are many points of which theory yet fails to give any convincing explanation.

Prof. Voigt's book is founded on lectures given by him at Göttingen University. The material thus available, however, has clearly been greatly extended and amplified, with results which may be regarded as exceptionally satisfactory. Thus the elementary and fundamental facts of observation, as well as all the more important experimental appliances and apparatus, are very fully and clearly described, while, on the other hand, a large amount of detail as to the latest developments, both in experiment and theory, is included. In a branch of knowledge so necessarily subject to modification under the influence of new ideas, it is usually to be expected that a volume will be already almost antiquated by the date of its publication, but one of the chief claims of the present work to attention is the extent of the information given as to the most recent work.

The first two chapters are devoted to setting forth the fundamental observations and the principal experimental methods and developments in connection with the Faraday effect and the Zeeman effect. The two chapters following, covering some 120 pages, are concerned with the explanation of these observations on the electron theory. The chief feature of Voigt's own work is the establishment of a simple connection between the emission and absorption phenomena and the rotatory effect of the magnetic field, and the development of the theory here given is founded on the series of papers published by the author between 1898 and 1902 in the *Annalen der Physik*. The theory is, however, here further extended, and includes, in chapter v., a discussion of Becquerel's more recent experiments on crystals of compounds of the rare earths.

The remaining chapters are devoted to the discussion of the "magnetic" Kerr effect, and the consideration of the fundamental phenomena of electro-optics. In the field of electro-optics the experimental difficulties have rendered progress slow. Insulation breaks down under very high voltages, and conduction is never entirely absent, and more refined methods of observation are necessary before the indications of theory can be verified. The subject is, however, of great theoretical interest and importance, and the publication of the present work will no doubt do much in stimulating further research.

(2) The general plan of the "Cours de Physique," of which the present volume is the fifth part, is somewhat unusual. The volumes previously issued bear the titles:—(1) "Mécanique Physique"; (2) "Thermodynamique—Théorie des Ions"; (3) "Électricité et Magnétisme"; (4) "Optique. Étude des Instruments," the part here considered being devoted to the general discussion of electromagnetic radiations, including Hertzian waves. Part vi. is to be entitled "Étude des Symétries"; from the references in the present volume we gather that this might best be translated "Crystallography." We are by no means clear that the arrangement thus outlined is satisfactory. In the volume before us especially, the inclusion of the discussion of Hertzian waves, though entirely logical and perfectly defensible on theoretical grounds, seems to us unfortunate. The questions involved are essentially practical and of special interest to the electrician, and the early chapters devoted to

their treatment form a section quite distinct from the remainder of the volume.

At the same time, it must be remembered that the whole work is one written for the student, and from this point of view it may be maintained that the logical arrangement is to be preferred. The usefulness of such an extended general treatise on physics is, however, far from being limited to the purposes of a university course, and the convenience of the older student who needs his theory for its application to practice might well have received more consideration.

It is to be remarked also that Prof. Bouasse's "Cours de Physique" is essentially a treatise on mathematical physics. The author takes a keen interest in the most recent developments in physical science from the theoretical point of view, but it is not to him that we should turn for information as to experimental work.

This premised, it may be said that the work is one which should command attention. Prof. Bouasse has the faculty of presenting his mathematics in a clear and attractive form, and his theoretical discussion of practical points often presents novelties of value to the practical experimenter.

The first chapter is devoted to the discussion of Maxwell's equations of the electromagnetic field. It is unfortunate that so much reference to vol. iii. of the work should be necessary, but, nevertheless, the matter is presented with admirable clearness, and the student has no cause to complain of the author's dictum :—

"The reader cannot spend too much time on this first chapter; if he understands it well, all the rest of the volume will appear clear to him. If he fails to understand it—*nous ne saurions trop lui conseiller d'abandonner la théorie électromagnetique de la lumière.*"

Then follows the section of some seventy pages on Hertzian waves and their application in wireless telegraphy. The treatment is of interest; it includes an account of the general theory and a mathematical discussion of various practical questions, especially the propagation of a disturbance along a wire; but it is necessarily incomplete, and would be of more value in a volume not so specially devoted to optical theory.

The main part of the work is that devoted to the discussion of double refraction and of polarised light. The theory is directly based on that of the propagation of electromagnetic waves in an anisotropic medium; from this is deduced the equation of the wave surface and the construction of Fresnel. This leads up to a sufficiently full treatment of the phenomena connected with double refraction as dealt with in any modern treatise on physical optics; as elsewhere, the mathematical presentment has many original and attractive features.

In the succeeding chapters reflection and refraction, dispersion and absorption are fully discussed from the standpoint of the electromagnetic theory. A somewhat brief treatment of the electron theory leads to the consideration of the Zeemann effect, and the phenomena of emission, phosphorescence and fluorescence, &c., while the concluding chapter deals with the thermodynamics of space, including such topics as Poynting's experiments on radiation pressure and the discussion of Stefan's law.

As has been sufficiently indicated, the whole of the section of physical optics here dealt with is treated as a deduction from the equations of the electromagnetic field. This may be a simplification from the point of view of theory, but we are inclined to think that to the student it may give an air of unreality to a subject which, above all others, is based on the most complete and exact experimental data.

OUR BOOK SHELF.

On the Poison of Venomous Snakes and the Methods of preventing Death from their Bite. Reprinted papers by the late Sir Joseph Fayrer, Sir Lauder Brunton, and Major Leonard Rogers. Pp. iii+174. (London : Macmillan and Co., Ltd., 1909.) Price 2*s.* 6*d.* net.

THIS publication consists of a re-issue in book form of six papers reprinted from the Proceedings of the Royal Society. The first four papers deal with the physiological action of snake venoms. They were first published more than thirty years ago, and then represented important advances in knowledge. They cannot, however, be expected to reflect the present-day knowledge of the action of snake venoms. The fifth paper, belonging to the same period, deals with chemical methods of destroying the activity of cobra poison, such as by chloride of gold or of mercury. The last paper, which was published in 1904, and is the only one of the series in which the last-named author cooperated, deals with the experimental results of the treatment of snake-bite by free exposure of the wound and local application of potassium permanganate.

To be of practical service in the treatment of snake-bite, any remedial measure must be rapidly available and easily applicable. To meet these conditions, one of the authors devised a special instrument consisting of a small lancet-shaped blade to expose the wound made by the serpent's bite, this blade being set in a short wooden handle, which is hollowed so as to form a receptacle for sufficient permanganate of potash. Experiments were made on rabbits and cats to test the value of the method and instrument. The results, especially in the latter animals, were encouraging, in so much as it was found that death could be prevented from a dose of venom considerably larger than that which was sufficient to kill a control animal. At the same time, it may be pointed out that the conditions of these experiments do not represent adequately the conditions obtaining in an ordinary case of snake-bite. The efficacy of the antidotal action of potassium permanganate depends solely upon how far the venom can before absorption be destroyed by intimate contact with the permanganate. In the authors' experiments the venom was injected into the subcutaneous tissues, in which case it was relatively easy to ensure contact of the venom with the antidote, whereas in a case of snake-bite the venom is injected usually into deeper tissues, when it is much more difficult to bring the permanganate into contact with the venom. It is thus probable that these experimental results ascribe to this method of treatment a value higher than would be found to attend it in practice.

While from its simplicity and cheapness this method of treating snake-bite ought not to be lost sight of, it probably does not represent the ideal attainment, which is by local application and general administration of an antivenomous serum, and further efforts ought to be made in the direction of obtaining such serums of

high antidotal properties. If dried, an antivenomous serum retains its neutralising power for a long period, and it possesses this great advantage over a mere chemical antidote, that it can also antagonise venom which has been absorbed, and may thus be of service for a longer time after injection of the venom.

Bathy-orographical Map of Africa. 1–8,400,000. *Bathy-orographical Map of Asia.* 1–9,300,000. (Edinburgh: W. and A. K. Johnston, Ltd.) Price 12*s.* each.

WE must congratulate Messrs. W. and A. K. Johnston on these excellent additions to their series of orographical maps. The elevations in Africa show 10,000, 5000, 2000, and 1000 feet and below sea-level. The general effect is satisfactory, though the very deep green is, we think, somewhat unpleasing. The 10,000-feet contour shows the higher elevations of the Atlas, Abyssinia, the Lakes Plateau and the Drakensbergen, but the tint is indistinguishable by a class. It would, however, have probably made the map more useful if the 8000-feet line had been selected, as the highest points are not of great importance for an educational map except in the region of the great lakes. As it is, the mountainous areas do not indicate their special character.

The other contours selected show the formation of Africa well. The sea depths shown are 100, 1000, 2000, and 3000 fathoms. It is to be regretted that the same contours have not been chosen to represent both the land and sea, as the plateau character of Africa would have been brought out with much greater effect.

Both in Africa and Asia, physical names have been very fully shown. As they cannot be read by a class, it is a pity that they have not been printed faintly in blue, like the initial letters of towns. The mass of black lettering largely spoils the graphic character of the maps.

Actual mistakes are few, though one may be noted—in the north-east of Abyssinia the area below sea-level has been coloured as more than 1000 feet.

The map of Asia is more effective than that of Africa, possibly owing to the selection of the contours. The 10,000-feet affords a means of comparison with Africa, but it should, if possible, have been printed the same depth; then the 15,000- and 20,000-feet lines would, with suitable graduation, have illustrated the character of the Tibet Plateau. At present minute and close examination is necessary to distinguish the features of the North-West Frontier. The lower elevations are much better shown. The 100, 3000, and 6000 feet bring out well the great river valleys and depressions of Asia.

In spite of these defects, the maps are likely to prove more useful for schools than any that have previously been published of these continents.

Publications of the Research Defence Society. March, 1908, to March, 1909. Selected by the Committee. Pp. xv+216. (London: Macmillan and Co., Ltd., 1909.) Price 2*s.* 6*d.* net.

THE Research Defence Society was founded on January 27, 1908, "to make known the facts as to experiments on animals in this country; the immense importance to the welfare of mankind of such experiments; and the great saving of human life and health directly attributable to them." The president is the Earl of Cromer, himself a champion in the cause of kindness to animals; the committee is a strong one, its members representing all branches of science, and also including many theologians and laymen, and in March of this year the membership of the Society numbered more than 2250.

This first volume of publications contains the president's address at the inaugural meeting, a review of the Home Office Report for 1907 on, and some facts as to the administration of the Act regulating, experiments on animals, and several essays (also published separately in pamphlet form) by well-known experts dealing with the knowledge that has been derived from experiments on animals, and the saving of human life therefrom. Prof. Cushny shows that the nature of the action and therapeutic use of all drugs of recent introduction, and the potency of the preparations of many of the older drugs (*e.g.* digitalis and ergot), have been elucidated solely by experiments on animals, the value of diphtheria antitoxin and of serum treatment in epidemic cerebro-spinal meningitis (spotted fever) is discussed by Dr. Courtauld and Dr. Robb respectively, Sir David Bruce writes on the extinction of Malta fever, and Dr. Bashford's article in NATURE on recent advances in knowledge of cancer is reprinted. The evidence of Lord Justice Fletcher Moulton before the Royal Commission on Vivisection is given *in extenso*, and is a powerful vindication from the ethical side of the right to employ experiments on animals for the benefit of mankind.

If the standard of its publications be maintained at the level of those contained in this volume, the Society will be doing excellent work in the cause of experimental research. R. T. H.

Milk Testing. A Simple Practical Handbook for Dairy Farmers, Estate Agents, Creamery Managers, Milk Distributors, and Consumers. By C. W. Walker-Tisdale. (Northallerton: W. R. Smithson.) Price 1*s.* net.

THE author of this little book is already favourably known by his early publications, jointly with Mr. T. R. Robinson, on butter-making and soft cheese-making. He holds an important position in the dairy world, and, as general manager of the Wensleydale Pure Milk Society, knows at first hand all the difficulties that beset the dairyman. The result is an admirable little volume, sound in regard to analytical methods, and direct in its appeal to the man for whom it is intended. It is more than a mere collection of methods, and includes discussions of such cognate subjects as the use of preservatives. Occasionally a request is heard in certain quarters that a preservative should be allowed in milk, but our author will have none of it, and advises the dairyman to keep clear of them all, even of a certain preservative offered for sale, "guaranteed to contain no boron or boric acid, and claimed to be undetectable by chemical analysis"! Quite apart from considerations of the general health of the community, the author shows that the dairyman himself would suffer, since foreign milk would invariably be imported if preservatives were allowed. E. J. R.

The Journal of the Cooper Research Laboratory. Edited by Walter E. Collinge, Director. (Berkhamsted: The Cooper Research Laboratory, 1909.)

THE fact that the principal of a large and well-known firm like Messrs. Cooper should start a research laboratory and publish a journal is a satisfactory proof of the widespread interest now being taken in science by all who have to do with agricultural and horticultural matters. The special province of the firm—treatment of insect and fungoid pests—certainly borders more closely than usual on pure science, and no doubt a trained staff would have been wanted in any case. But here we have something more. The laboratory, we are told, "is in no sense a financial venture or business concern." Its functions are to answer inquiries from farmers, fruit-growers, and gardeners as to preventive and remedial treatment for diseases of plants and parasitic diseases

of animals, to investigate life-histories of various insects, parasites, &c., and generally to advise on subjects relating to economic biology, agricultural chemistry, and bacteriology.

The articles in the journal are mainly summaries of work done elsewhere rather than accounts of original work; perhaps this was only to be expected from an almost new laboratory. Mr. Collinge deals with the use of lime, with special reference to its influence on plant diseases like potato-scab and finger-and-toe fungus; he has also collected a good deal of scattered work on the woolly aphis. Mr. Barlow deals on similar lines with the effect on plants of copper salts used as fungicides. The summaries themselves call for no special comment, but the journal as a whole is well got up. We shall be interested to see how Sir Richard Cooper's experiment works—whether the laboratory can maintain the detached position essential for the publication of scientific work, or whether, as has happened elsewhere, it becomes merged in the purely commercial side.

Cambridge County Geographies: Somerset. By Francis A. Knight, assisted by Louie M. (Knight) Dutton. Pp. xi+192. (Cambridge: University Press, 1909.) Price 1*s.* 6*d.*

THE characteristics of the series to which this volume belongs were enumerated in our issue for May 13 (vol. lxxx., p. 305), and much of what was written on that occasion applies to the present book. The authors' interpretation of the scope of geography is wide enough to include a history of the county, its antiquities—ecclesiastical, military, and domestic—its administration and roll of honour. Like previous volumes in the series it is well illustrated, brightly written, and generally attractive.

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.]*

Difference between Longitudinal and Transversal Zeeman Effects in Helium Lines.

IT is easily shown on the theory of electrons that the amount of separation of the outer components of a transversal Zeeman triplet must be slightly different from that in a longitudinal doublet. Some time ago I showed that the transversal separation in weak magnetic fields does not strictly follow the linear relation with the magnetising force, but, owing to an indirect method of measurement, the exact amount of the separation could not be measured with accuracy. By measuring the longitudinal effect of helium lines with an echelon spectroscope of thirty-five plates, each of 1 cm. thickness, made by Hilger, I found that doublets can be distinctly separated in a field of 180 gauss, when the right- and left-handed circularly polarised light is linearly polarised in mutually perpendicular directions, by interposing Fresnel's rhomb in the course of the beam. Taking a number of points at intervals of about 300 gauss from H=0 to H=2000, and ten to thirteen points from H=2000 to H=14,000, I found that for the three lines $\lambda\lambda$=6678, 5876, 5016, the relation between the amount of separation $\delta\lambda$ and the strength of the field H is exactly linear, so that $\delta\lambda/H$=constant also in weak fields. In these experiments it was necessary to gauge the strength of the field accurately for each point before and after each micrometric measurement by means of a small coil. The values of e/m were found to be for

λ=6678	$e/m=1{\cdot}86\times10^7$
=5876 (D_3)	$=1{\cdot}68\times10^7$
=5016	$=1{\cdot}80\times10^7$

The separation of the satellite of D_3 is complex, but there is one component which gives the same value of e/m as D_3.

With the transversal effect the ratio $\delta\lambda/H$ is not constant in weak fields. With D_3, the curve representing the relation between H and $\delta\lambda$ is such that it increases very slowly to H=800, then rapidly to an inflexion point in H=1700, makes a bend, and from H=2000 follows an accurately straight course up to H=14,000, which is the strongest field used in the present experiment. In the latter part of the curve $d(\delta\lambda)/dH$=constant, which is smaller for the transversal than for the longitudinal effect, so that the curves representing these effects cross each other in H=1200 and H=10,900. The initial part of the curve for the transversal effect shows a striking resemblance to that of magnetisation in ferromagnetic substances. The satellite accompanying D_3 shows remarkably complex separation, as shown by Lohmann, but there are two components which take a similar course to the principal line D_3. The lines are already separated before reaching the inflexion point above mentioned, so that the method which I used in my former experiments, is confined only to weak fields. With the line 6678, the initial course of the curve for transversal effect is similar to that of D_3, but the inflexion point is reached in a higher field H=2700, and the curve becomes a straight line from H=3600 upwards. The curve for longitudinal effect lies entirely above that for the transversal, and $d(\delta\lambda)/dH$ in strong fields is greater for the former than for the latter.

The usual calculation of e/m is made on the supposition that $\delta\lambda/H$=constant, which is strictly obeyed in the longitudinal, but not in the transversal, effect; the discrepancy in the value of e/m calculated from longitudinal and transversal effects is at once explained. The initial course of the curve can be accounted for by Voigt's theory, but the appearance of the inflexion point before attaining the straight course presents some difficulty. The resemblance of the curve of transversal effect to that of magnetisation seems to have an important bearing on the exposition of the theory, which would explain these characteristic features. The extension of these experiments to stronger fields and with different elements is being undertaken.

H. NAGAOKA.

Physical Institute, University of Tokyo, July 16.

Natural Selection and Plant Evolution.

THE letter from Mr. James B. Johnston in NATURE of August 5 touches on many important points, which cannot be fully dealt with in a letter of reasonable length.

In his opening sentence the writer, speaking of chapter xii. in "Darwin and Modern Science," says that "there, perhaps for the first time, the evidence of the fossils with regard to the influence of natural selection has been fairly tackled"; I may point out that the chapter cited really relates mainly to evolution, and especially phylogeny; only the last section refers to natural selection, a subject on which, from the nature of the case, the fossil record can throw comparatively little light.

I cannot think that, on the main question, there can be any very fundamental difference between the writer's views and my own, for he says:—"In the case of the Tertiary mammals the action of natural selection can be very clearly demonstrated in numberless cases." Mr. Johnston cannot seriously mean that he accepts natural selection for animals and rejects it for plants. The question is simply one of evidence. As I have myself pointed out, the direct evidence for the derivation of one species from another is at present less satisfactory in the plant than in the animal record ("Darwin and Modern Science," p. 204); on this point we may hope for new light from further research, though, as regards the efficacy of natural selection (an essentially different question), I doubt if palæontological evidence will ever be really decisive.

My point in speaking of the evolution of the pollen-tube and seed was to show that such characters are *adaptive*, a view to which Mr. Johnston is not likely to object. In the present position of biological science evidence of adaptation is commonly accepted as presumptive evidence of the action of natural selection.

The question whether a belief in the efficacy of natural selection can be regarded as "barring out all design from the world in which we live" is not one that can be dis-

cussed here. Mr. Johnston will find this subject admirably treated, from a theologian's point of view, in Mr. Waggett's contribution (chapter xxiv.) to "Darwin and Modern Science."

The question of the antiquity of land-plants is of great interest. Assuming, for the sake of argument, that the highly organised lycopods and fern-like plants described by Prof. Potonié as Upper Silurian ("Die Silur und die Culmflora des Harzes Geb.," *Abhandl. d. k. Preuss. Geolog. Landesanstalt*, Heft 36, 1901) were really of that age, it would appear certain that land-plants must then have already passed through a very long course of evolution. No one is likely, in these days, to suppose that Bothrodendron and Sphenopteridium were specially created. The doctrine of mutation (of which Mr. Johnston appears to be an adherent) does not materially help in hurrying up the process of evolution, for, as Prof. de Vries himself says, "Mutations do not necessarily produce greater changes than fluctuations" ("Darwin and Modern Science," p. 73).

The problem confronts us, and its solution must simply await further evidence. D. H. SCOTT.

Oakley, Hants.

The Perseids of 1909.

THE weather, fortunately, took a very favourable turn on August 3, and observations have been obtained nearly every night since, though moonlight has rather seriously interfered with the work and obliterated many small meteors. Up to August 9, and including that date, the display of Perseids was decidedly poor, and quite disappointed expectation. On August 7 and 9, particularly, there appeared to be very few meteors, but the moon was shining rather strongly in the east.

On August 8 there were several brilliant Perseids observed. At 10 p.m. a fine, long-pathed meteor shot from Camelopardalus across κ Draconis towards ζ Ursæ Majoris. At 10.8 p.m. another Perseid, equal in brightness to Jupiter, passed from χ to between β and η Draconis. At 10.34 p.m. a third shot exactly from α Cygni to close to β Cygni. These meteors left streaks, and, in combination with a few other paths recorded on the same night, indicated a radiant at 41°+57°.

The shower will probably arrive at its most abundant phase on August 11 or 12 this year, so that the meteors already reported are merely the vanguard of the approaching main group. W. F. DENNING.

Bristol, August 10.

The Ringing of House-bells without Apparent Cause.

KINDLY allow me space for a few remarks upon Sir Oliver Lodge's theory, put forth in NATURE of July 22 (p. 98), to the effect that "the bells get charged with electricity (atmospheric), and are attracted to a neighbouring wall or pipe, and then released suddenly by a spark." Now, while it is conceivable that a bell might be rung under certain conditions in this manner, during the progress of a thunderstorm or display of sheet-lightning, and granting that ordinary non-electric bells have been rung and wires fused when a house has been struck by the electric current during such storms, still, this theory is inadequate to explain those cases of mysterious bell-ringing on record, and for one reason, among others, that these ringings, often violent and prolonged, have been extended over a term of several weeks or months, and have constantly taken place when no storms or strong electrical conditions were apparent, and when every effort was being made to ascertain the cause.

I speak from personal experience of a case which occurred in my house when resident in the south. For a period of two months there were constant ringings—often violent, the bell lashing to and fro—of the indoor bells, without apparent cause. In the case of one bell the wires were cut, but still it rang. The utmost endeavours were made to solve the mystery, but it defied all our efforts. There were no rats, the house having been made rat-proof, nor did we see one rodent during our stay. The wires were carefully traced and examined. Pendulums were affixed to all the bells to detect slight motion, and they were strongly illuminated by a powerful light and a watch kept, sometimes all through the night. The chief offender among the bells was one communicating with a private room. The wire from this ran, high up near the ceiling, upon the varnished paper, except where it passed through a wall, which it did through a half-inch pipe. It was impossible for a rat or mouse to touch it all along its course. This bell rang repeatedly from early morn to late at night. The room was thoroughly searched and secured—the shutters put up and barred and the door locked. Still the bell rang, and defied all our efforts to elucidate the mystery. On one occasion, when the whole household was together in another room, some little distance away, one of them said, "I wonder if it will ring to-night?" The words were scarcely spoken before the bell rang out, first faintly, then so violently that the bell lashed from side to side. All ran out and saw it swaying. I can state that during the whole period we had no thunderstorm, it being winter, and the ringings were so frequent that it would have needed scores of storms and abnormal electrical conditions to produce them, even if these had been the cause. This theory is ingenious, but one doubts whether Sir Oliver advances it seriously. Whatever is the cause of these mysterious ringings, it is patent to anyone having had experience of them, or knowing the cases on record, that it is not electricity, atmospheric or other. C. L. TWEEDALE.

Weston Vicarage, Otley, Yorks, August 6.

Variation in Relative Intensity of Helium Lines.

IT has long been an open question whether the spectra of gases were subject to any general law of intensity variation such as the Wien-Paschen displacement law for incandescent solids. Reasoning from Kirchhoff's law, it is frequently assumed that the Wien-Paschen function must be an envelope to the radiation spectrum of any gas, at least for certain selected lines. Pflüger's work with the mercury lamp (*Ann. Ph.*, July, 1908) indicated some such variation in relative intensity, but the energy (temperature) effect was obscured by the effect of varying vapour density. The latter is known to be large, so that the existence of the former was not proven.

We have recently taken up this question, using a pair of helium lamps containing very pure gas at 5 mm. pressure, and found *no variation* whatever when the intensity was varied by a factor of eighteen. The method was to hold one of this pair of lamps constant at a moderate current (5 milliamperes per mm.^{2}), while the intensity of the other was varied from 0·15 to 2·70 times this value. Spectrophotometric settings were made on the brightest red line (λ 668) and the bright blue line λ 447. The uncertainty in the ratios of high/low intensities was less than 2 per cent. in both red and blue; the observed difference in these ratios between red and blue was less than 1 per cent. The red and blue lines then increase in the same proportion over a wide range of intensity.

According to the Wien-Paschen function, an incandescent body should, for an increase in total radiation of 18 fold, increase in temperature 2·06 fold. If this increase is from 1500° to 3090°, then λ 668 would increase in that range 1721 fold, and λ 447 would increase 66,850 fold in intensity, so that the blue increases 38·8 times as much as the red, whereas for helium we found no difference so great as 1 per cent. P. G. NUTTING.

ORIN TUGMAN.

Department of Commerce and Labour, Bureau of Standards, Washington.

Kohlrausch's "Physical Measurements."

I SHOULD like, through the medium of NATURE, to direct attention to an erratum in Kohlrausch's "Physical Measurements" (third English edition, Churchill, 1894), p. 434, table 8. The value for $k(s=2·0)$ is given as 0·458, its true value being 0·457(1). Other editions, English or German, not being at hand, I do not know whether the mistake is repeated or not. As this occurs in a very useful table in a universally used reference work, it should be of interest to a number of your readers.

E. W. NELSON.

The Laboratory, Citadel Hill, Plymouth, August 2.

THE BRITISH EXPLOSIVES INDUSTRY.[1]

A VALUABLE addition to the literature on explosives has been published under the auspices of the seventh International Congress of Applied Chemistry by its explosives section, with Mr. Brayler Hodgetts as editor. It owes its inception to Mr. Oscar Guttmann, to whom the publishers pay a well-deserved tribute for his able assistance and the facilities he has afforded them by placing his unique and valuable library at their disposal.

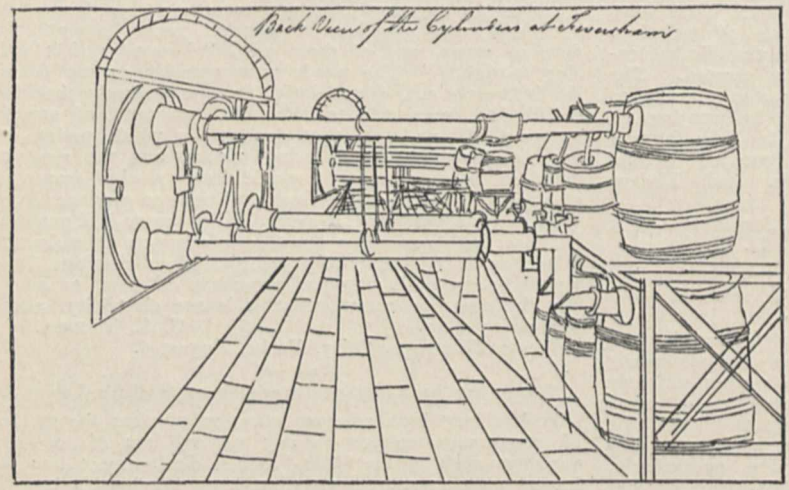


FIG. 1.—Charcoal Chambers in 1798. Back View. Reduced from "The Rise and Progress of the British Explosives Industry."

All who have been associated with the compilation of the work are to be highly congratulated on having produced a volume which will certainly fulfil the hope expressed by Captain Tulloch in his preface, that it will "in years to come be looked upon as a work of reference connecting the past with the future," for all will agree with him, after perusing it, that "it is the only work of the kind containing so complete a history of the manufacture of explosives in this country."

The book is divided into two main sections, historical and descriptive. In the former are articles devoted to each of the principal explosives, and such related subjects as percussion caps, safety fuses, and fireworks, contributed by writers specially competent to deal with each. It is impossible to single out any one article for comment, but the contributions of Mr. G. W. Macdonald on the literature relating to researches on gunpowder, nitroglycerine, and nitrocellulose, with the full references to the original papers, will prove of considerable value.

Outside of what may be regarded as the purely scientific or technical articles, that on legislation, contributed by the editor, is of great interest. Although prior to 1860 there had been many Acts placing restrictions on manufacture and storage, the supervision was very lax, leading to great carelessness in the manufacture and handling of such dangerous substances. Colonel Moody's report on the disastrous explosion of powder magazines on the river-bank at Erith in 1864 (from which report some startling extracts are given) fully emphasised the necessity for more stringent regulations, and led in October of that year to the appointment of Colonel Boxer to "inspect and examine any mill, magazine or place" in which any kind of explosive was manufactured or kept. Later, a further disaster at Birmingham, by which fifty-three lives were lost, resulted in the appointment of permanent inspectors on the recommendation of the late Colonel Sir V. D. Majendie, K.C.B., who, as chief inspector, became so well known to the public at the time of the Fenian outrages. The Explosives Act of 1875 was the final outcome of these disasters, an Act which has proved of the greatest value through the tactful administration of the inspectors and the conscientious manner in which its provisions have been observed by the industry.

Special mention must be made of the bibliography and of the chronology. It is claimed for the former that it gives a complete list of the books on explosives published in England, whilst the chronology covers the period 1242–1700, and is a remarkably complete work reflecting the greatest credit on those responsible for its compilation. The licences granted and the restrictions imposed for the sale of the ingredients of powder and for its manufacture are often extremely quaint and of great interest. This chronology should appeal to the antiquarian equally with the student of applied science.

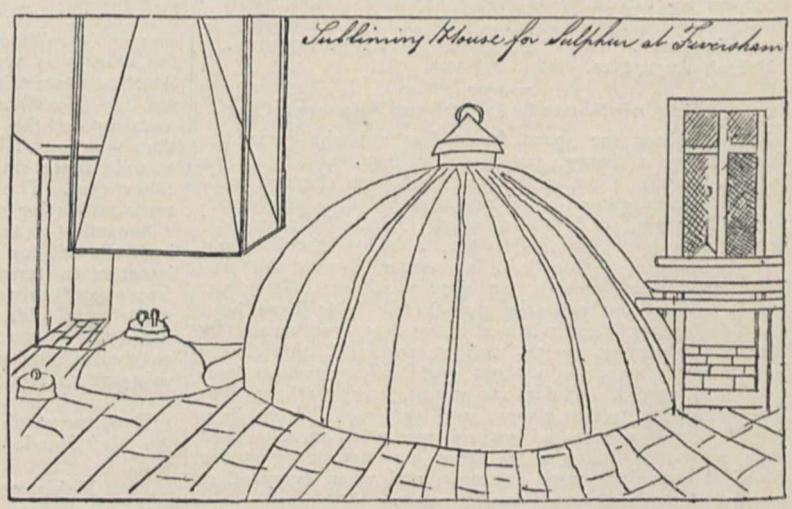


FIG. 2.—Sulphur Subliming Chamber in 1798. Side View. Reduced from "The Rise and Progress of the British Explosives Industry."

In the second section of the book, devoted to description of existing factories, the information as to development, specialities of manufacture, organisation, &c., is very complete. Space only permits of reference to the articles dealing with Government

[1] "The Rise and Progress of the British Explosives Industry," Published under the Auspices of the Seventh International Congress of Applied Chemistry by its Explosives Section. Pp. xiv+418. (London: Whittaker and Co., 1909.) Price 15s. net.

establishments, in each case written by the superintendent—the Royal Laboratory, Woolwich, by Colonel Sir Hilaro Barlow; the Royal Gunpowder Factory, Waltham Abbey, by Colonel Sir Frederic Nathan; and the recently re-constituted Research Department at Woolwich, by Major H. Mansell. The history and development of these important Government establishments will prove of general interest. The Royal Laboratory alone must be prepared to manufacture at short notice some 3000 articles of approved design for war purposes. An interesting comparison of the cost of shells may be quoted. In 1849 the finished shell for 8-inch smooth-bore guns alarmed the authorities. It was 11*s.* 3½*d.* The modern 12-inch shell costs about 29*l.* when completed!

One extract may be permitted from Colonel Jocelyn's article on military fireworks. "In the Mathematical Society of London a rule existed which imposed a fine of sixpence on any member who should let off fireworks in the place of meeting." This but reflects the playfulness of the times when Pepys and his friends enjoyed pelting each other and "the people over the way" with fireworks.

The book is illustrated with some fine portraits of those who have been prominently associated with the industry, and a number of old illustrations of powder-making processes, which greatly add to the value of the work. Those selected for reproduction are of more general interest than others relating to powder manufacture itself. The recovery of by-products from the carbonisation of wood, as shown in the first illustration (Fig. 1), cannot fail to be of interest to chemists, as will also the sulphur-refining plant (Fig. 2) with its retort, fume-hood, and condensing chamber. J. S. S. B.

DANISH RESEARCHES ON THE EEL AND THE PLAICE.[1]

THE "Kommission for Havundersøgelser," the official body entrusted with the execution of Denmark's share in the international exploration of the sea, devotes a considerable portion of its resources in endeavouring to solve certain important problems connected with the natural history of the eel and the plaice. These investigations are producing very definite results.

Two papers recently contributed by Dr. Johs. Schmidt to the "Meddelelser" of this commission considerably advance our knowledge of the metamorphosis and distribution of the larvæ of the eel and other murænoids. Since the publication of Dr. Schmidt's notable treatise of 1906, in which the distribution of the larvæ of the eel in the Atlantic, west of Europe, was described in detail for the first time, a large quantity of new material has been collected by means of the Danish research steamer *Thor*.

The new captures included more than 500 larvæ of the common eel, 300 of which were in different stages of metamorphosis. The material previously dealt with (in the treatise of 1906) consisted of 265 specimens, only eight of which showed an advance on the leptocephalus stage. Taking the captures of 1905 and 1906 together, the following is a list of the leptocephali of murænoids so far taken by the *Thor*:—Leptocephalus of eel, 790; of Synaphobranchus (deep-sea eel), 126; of the conger, 32; other leptocephali belonging to four unknown species, 12.

Confining our attention to the common eel, it may be said that these new researches throw light on obscure points, amend former statements, and fill up several gaps. The more important new facts may be briefly summarised as follows:—

(1) In May all the leptocephali were in stage 1; in September they were mostly in various stages of metamorphosis. This implies that the propagation of the eel is limited in the main to a certain portion of the year, as is the case with most other fishes.

(2) In September the later stages were found further towards the shore than the earlier stages. This indicates shoreward migration during metamorphosis.

(3) It was found that both leptocephali and glass eels were larger in the southern than in the northern part of the area of distribution.

(4) Whereas in the treatise of 1906 calculations of the shrinkage of the larvæ during metamorphosis were based on fragmentary material, belonging to different regions and different years' groups, it is now possible to say definitely that the diminution in length involved in the retrogressive metamorphosis amounts to 1 cm. This average is based on a large number of measurements of leptocephali and glass eels *from the same region, and belonging to the same year's group*. Further, weighings of leptocephali and glass eels prove for the first time that the metamorphosis involves an actual loss of substance, the dry-weight of glass eels being only one-third of that of leptocephali.

(5) There is good evidence that the larvæ execute diurnal vertical movements in the sea, coming nearer the surface at night than during the day.

(6) There are places where the larvæ of the eel are the commonest fish, just as we find in the case of the different species of gadoids, each of which (as we know from Dr. Schmidt's own investigations) chooses its own conditions of depth, salinity, and temperature for spawning purposes. Thus the specific trait shows itself in the selection of spawning habitat, as well as in anatomical and physiological peculiarities.

The first and final chapters of this weird and fascinating history have yet to be written. Neither the eggs nor the spawning adults have been found, though there is good reason to believe that the former are bathypelagic, *i.e.* floating at considerable depths, as is the case with other murænoids, Argentines, and other deep-sea fishes. The discovery of these things can only be a matter of time and resources. Ships and men are not lacking, apparently.

In regard to other murænoids, the recent investigations show that the conger is a more southern form than the eel. Its larvæ do not range further north than Rockall, whereas the leptocephali of the eel extend to the latitude of the Færöes. The larvæ of the conger do not occur over such great depths as those of the eel. They show the same inshore movement during metamorphosis, there being a close connection between depth and pre-anal length.

The larvæ of the deep-sea eel (*Synaphobranchus pinnatus*) were never taken so near the surface as the leptocephali of the common eel, never higher in the water than 100 metres. In the case of this species there is nothing to suggest shorewards migration. During metamorphosis the larvæ sink to the bottom in deep water, where fully-developed eels of this species were caught in large numbers over a wide area of the north-east Atlantic.

Of the other leptocephali (four kinds) it is impossible to say at present to what species they belong,

[1] Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri. Bind iii., Nos. 1, 3, 5, and 6.

No. 1. C. G. Joh. Petersen: On the Larval and Post-larval Stages of some Pleuronectidæ (Zeugopterus, Arnoglossus, Solea). With two plates.

No. 3. Johs. Schmidt: Remarks on the Metamorphosis and Distribution of the Larvæ of the Eel (*Anguilla vulgaris*, Turt.). With one plate and one chart.

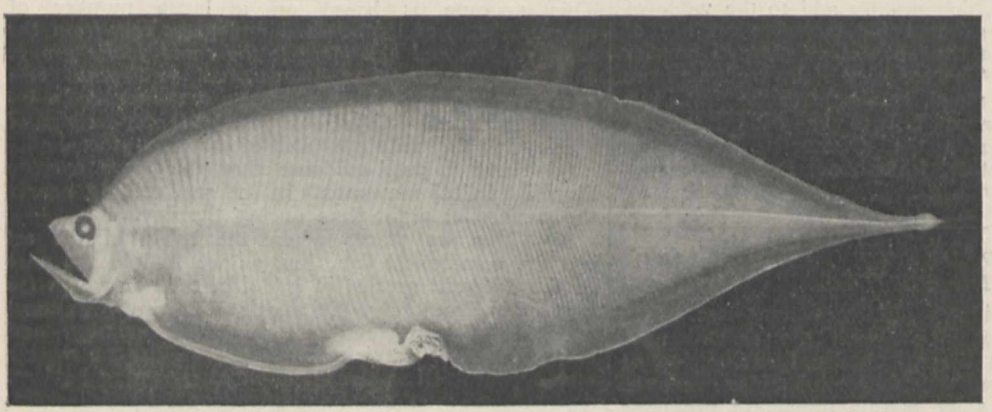
No. 5. A. C. Johansen: Contributions to the Biology of the Plaice, with special regard to the Danish Plaice Fishery. iv. Is the Plaice Indigenous to the True Baltic? With Two text-figures.

No. 6. Johs. Schmidt: On the Occurrence of Leptocephali (Larval Murænoids) in the Atlantic W. of Europe. With two plates and one chart.

and it may be some time before this can be stated, owing to the difficulty of capturing the slippery and swift-moving adults. It will be necessary to have these for comparison with the leptocephali (*e.g.* to count the vertebræ). From the small numbers of these leptocephali captured, it is practically certain that their breeding-places or "nurseries" are considerably to the south of the Bay of Biscay.

Leptocephalus hyoproroïdes is particularly interesting, because it is the only species which it has been possible to trace back to the not fully-grown pre-leptocephalus stage, which, it is significant to observe, is also pelagic, like the later stages.

Much praise is due to those concerned in the production of the three beautiful plates of photographs which illustrate these two papers. One plate (in No. 3) shows seven stages (typical size) in the metamorphosis of the common eel. These figures are a great improvement on the photographs of the same series of stages published in Dr. Schmidt's original treatise; they are larger, and were taken from specimens in a much better state of preservation, so that they display the characters of the larvæ, especially the glassy transparency, more faithfully. The same remark applies to the plates illustrating No. 6. One of these shows seven stages in the *growth* of the pre-leptocephalus into the leptocephalus of "hyoproroïdes."



Leptocephalus latus. Slightly less than three times natural size.

Dr. A. C. Johansen, in No. 5, makes a very important original contribution to the much vexed question, "Is the plaice indigenous to the true Baltic?" For a long time, neither eggs, pelagic larvæ, nor early bottom stages of the plaice could be found in the true Baltic, and Dr. Petersen, the chief Danish scientific expert on sea fisheries, considered that the large stock of this fish in these waters must be entirely derived by immigration from the Belts and southern Kattegat. He thought that they must begin to immigrate when about one year old. As time went on, however, the capture of large numbers of eggs in the cold saline bottom water of the Baltic, and of *occasional* pelagic larvæ and bottom fry, seemed to indicate that this extreme view might require modification. It seemed unlikely, however, that the eggs could develop in the cold water at that depth, and the fact that the number of pelagic fry obtained were extremely few in comparison with the numbers of eggs and adults lent support to this view. But is was not impossible that the stock of plaice was partly, if not mainly, indigenous, being an "accumulated stock" grown up slowly by means of small additions from year to year. This problem had been the subject of continual investigation and discussion by German and Danish investigators under the international scheme, with, so far, inconclusive results. It seemed even probable that a third alternative might be the right explanation, viz. that the fry had not been looked for in the right places with the proper appliances. This seems to have been the case. Dr. Johansen, in the present paper, records the capture in the true Baltic of large quantities of yearling plaice "for the first time in such numbers as to compete with each of the older annual series." He also found that pelagic fry of this species were plentiful everywhere in the water between Falster and Bornholm. Other convincing evidence of the plaice being indigenous to the true Baltic is also brought forward, it being shown that the average size of plaice of a given age and the average size at first maturity are much smaller in the Baltic than in the Belts and southern Kattegat. This could hardly be the case if any considerable immigration from the latter regions took place. More light on this question may reasonably be expected from marking experiments in the future. The few experiments of this kind which have so far been made in this region have not yielded conclusive results.

In No. 1, Dr. C. G. Joh. Petersen gives the results of an exhaustive study of the diagnostic characters of Arnoglossus, Zeugopterus, and Solea in the larval and post-larval stages. These results (which need not be detailed here) are quite new. The author also discusses in a critical manner all previous observations in regard to these species and stages. Dr. Petersen is the greatest living authority on the later development of the Pleuronectidæ, and this paper and his other papers dealing with the subject are of standard importance, and indispensable to the investigator.

THE POSITION OF SCIENCE TEACHING IN PUBLIC SCHOOLS.

THE Board of Education has issued as an "Educational Pamphlet" a report on science teaching in public schools. The material for this report, made at the instance of the Association of Public School Science Masters, has been collected and edited by Mr. O. H. Latter, of Charterhouse, and the pamphlet is both instructive and amusing. The ground covered by the report is to some extent the same as in another report recently made by a committee of the British Association on the sequence of science studies in secondary schools; but a comparison of the two lists of questions sent out will show that Mr. Latter's investigation deals more particularly with equipment and finance. On the other hand, the field of inquiry was restricted to the class of school represented on the Association.

Of the seventy-one schools to which the circular was

sent, twenty-four made no response, and one sent a definite refusal. It is doubtless annoying to be asked twice in the course of a year to fill up forms which require minute particulars, perhaps not ready to hand, and it is possible—in fact a study of one of the appendices makes it probable—that some of the information has been supplied without meticulous verification of the details.

If we put schools into three science classes, (*a*) those born scientific, (*b*) those that achieve science, (*c*) those that have science thrust upon them, it will be found that only (*b*) and (*c*) are represented in Mr. Latter's report. Class (*b*) supplies all the most valuable information, and it is to be hoped that it will be found useful by the governors of the third class, now a very small one.

The opening pages of the pamphlet are retrospective and historical. Darwin's experiences at Shrewsbury are given, including the public rebuke administered by the headmaster for time wasted on chemistry. This uncompromising attitude gave place later to faint encouragement. There are still to be found those whose memory of Prof. Pepper's popular lectures supplies their ideal of a school science course. The first public school to achieve science was Rugby, and Canon Wilson's reminiscences are perhaps the most interesting pages of the whole pamphlet. He was appointed science master by Temple in 1859, and taught at first in the cloakroom of the Town Hall. A small chemical laboratory with six benches was built in 1860, and here he received a visit from Babbage, brought by Temple to look at one of the first spectroscopes. In due time the Rugby science master became headmaster of Clifton, and it was here that the next real advance was made. Prof. Worthington's "Physical Laboratory Practice, First Course," has been "the model on which nearly all the existing schemes of elementary physical work have been based."

In addition to Rugby and Clifton, the scientific histories of Cheltenham and Charterhouse are briefly related, the experiences of these schools being taken as typical of what has happened at other places. Again, to quote the words of the report, "The mere historical statement conveys very little idea of the conditions under which much of the earlier teaching was conducted. In most schools the idea underlying the new work was to impart a modicum of gentlemanly information concerning natural phenomena and such special branches of science as were attracting public attention and receiving some notice in the daily press."

Among the external influences which have helped to establish the position of science, the increasing importance attached to it in university examinations is regarded as the chief factor. The recent changes in the army examinations have led to an increase in the accommodation and the teaching staff. A well-deserved tribute is paid to the influence of Profs. Armstrong and Miall in the direction of reformed methods of teaching.

To turn from past history to present conditions, it may be said briefly that the result of the inquiry is in the main satisfactory. Governing bodies appear to recognise the claims and importance of science in the most practical manner, and in nearly every instance where laboratories are inadequate new ones are being built. No hint of insufficient funds appears to have been given in any of the replies. The financial question is fully dealt with. It is inevitable that science should cost more than any other subject. Apparatus and materials must be supplied and continually renewed. Gas, water, and electricity must be consumed. In addition to masters' salaries, assistants, trained or untrained, must be paid for. In the latter respect there appears to be a deficiency. "A large number of those responsible for school service have not yet realised the value and importance of employing at least one expert attendant."

In a few cases it has been possible to estimate the cost of the science teaching per boy per hour, including everything except masters' salaries, and the average is just under 3*d*. This may be regarded as a reasonable standard in schools where the science buildings form one block in which apparatus and attendance can be shared by different class-rooms. The schools which have put off the building of specially designed laboratories until the eleventh hour are fortunate in being able to make use of experience gained by those who have borne the burden and heat of the day. We are still feeling our way, but we understand much better than we did ten years ago what is indispensable and what is superfluous in a school science building. The methods of meeting the expenses of the science teaching are very various. Some schools charge an extra fee. In others the entire cost is met by the general funds of the school without any extra charge except in cases of culpable negligence. This, no doubt, is the ideal system, and ought to obtain wherever science is compulsory. On the other hand, when there has been no raising of the general fees to meet special expenditure incurred on behalf of a few, it is not unreasonable that those few should be asked to contribute. The important points in this connection appear to be, first, that no boy should be debarred from taking up science on grounds of expense, and, secondly, that no cheapening of the science course should be effected by lowering the salaries of the staff. Economies of this kind have been known, and have been accompanied by a lowering of the standard.

To turn now to the arrangement of classes and the sequence of studies, it seems that dissatisfaction with present circumstances appears to be infrequent. It may be taken, therefore, that the average conditions are not very far wrong. Mr. Latter finds that the average ratio of masters (in all subjects) to boys is 1 to 14·5, that one out of every nine masters is engaged solely in teaching science, and, allowing for help given by mathematical masters and others, the ratio of science masters to boys is about 1 to 70. These are important facts, and should be carefully considered by school authorities who are in doubt as to their curriculum.

One of the questions asked was, "Are science classes arranged in sets according to attainment in science or according to aggregate in all subjects?" Here is a practical problem of great difficulty. It is complicated by the lack of uniformity among preparatory schools and in public school scholarship examinations in their recognition of science. Thus a clever boy coming to a public school with a scholarship but without any training in science may find himself placed with boys who have already been at the school for one or two years and have passed through its elementary scientific course. The plan of rearranging an entire school of 500 according to attainment in science alone is, of course, impracticable, and in schools where the forms are grouped in blocks, subdivision of a block for science purposes can only be possible when the proportion of masters to boys does not fall below the average already stated. In some cases the classification for science is the same as that for mathematics, and this plan is commended to the consideration of preparatory schoolmasters as well as to those who teach elementary physics at public schools.

The sequence of subjects has already been dealt with in another report. Mr. Latter urges the claims of botany and zoology with some force, and publishes

in an appendix six different schedules of science work, which will doubtless be valuable and suggestive to teachers. In fact, the report should be read by all public-school governors and teachers, pastors and masters.

THE EGYPTIAN LAND SURVEY.[1]

THIS interesting volume forms a worthy termination to a piece of work of considerable interest and of immediate practical importance, the construction of the great land map of Egypt.

The fertile valley of the Nile has been a densely populated and closely cultivated tract from the earliest dawn of civilisation; so far back as 2000 B.C. methods of boundary delimitation and area computation are recorded as being in use, methods which, with modifications and improvements only at rare intervals, have lasted down to quite recent times. Seeing the intimate connection of the system of land tenure with the daily life of the people, we might be surprised to find that, up to ten years ago, there was in existence no general land map. It is, however, quite possible for a complex and orderly scheme of land-holding to coexist with an entire absence of maps—our own islands could be adduced as an example of this; in fact, it is not in general until required for fiscal purposes, *i.e.* for some form of land taxation, that a complete cadastre, or accurate large-scale map, is demanded.

In Egypt, when the present Survey Department was constituted in 1898, following upon a survey of State lands begun in 1892, it was found that though vast sums had been expended upon spasmodic efforts at map-making, no work of a permanent nature had been done and for all practical purposes most of the money so spent might as profitably have been thrown into the Nile. Thus, for example, during the ten years from 1878 to 1888 an elaborate cadastre of part of five provinces was made, but being based upon no system of triangulation or other accurate fixation of points, and being carried through so that no part of the work was really self-contained and complete, the whole was well-nigh valueless. In this way about 400,000*l.* was spent. If we cared to calculate the sums similarly wasted on previous abortive attempts we could doubtless exhibit a very handsome total, driving home the lesson that in map-making inaccurate and inefficient work spells, not only trouble and delay, but a large, direct waste of public money.

In 1898, however, this waste, so far as Egypt is concerned, came to an end; a standing survey department was established; the idea that the mapping of a region is a temporary business, which can be completed in a definite period and then set aside as finished—a delusion still found lingering in certain quarters—was discarded, and the whole work was started upon sound and permanent lines. The result of this wise procedure is that the administration now possesses a map of the cultivated area, upon a uniform scale of 1/2500, a possession of enormous value to the agricultural development of the country, without which it would be almost impossible equitably to collect the revenue due under the great water-supply schemes now in existence and likely to be undertaken in the future.

In general, we may fairly say that the account of a cadastral survey would not be of any appreciable interest except to the professional surveyor. In the case of Egypt, however, this limitation by no means holds, and many portions of the present volume, especially the descriptions of the old land measures and the methods of arriving at the areas of holdings, will be found attractive to the general reader. To the surveyor this graphic summary of modern map-making in the land generally accounted the birthplace of his science cannot fail to prove enthralling. There is possibly no country where exactly the same conditions are to be found as those obtaining in the Nile valley, but there is much in this volume applicable to the survey of any closely populated, flat district. Anyone who has the planning of such work, or who is in any way concerned with its execution, owes a debt of gratitude to Capt. Lyons and his staff for the trouble they have taken to place on record the fruits of their accumulated experience.

E. H. H.

[1] "The Cadastral Survey of Egypt, 1892–1907." By Capt. H. G. Lyons. Pp. viii+421. (Cairo: National Printing Dept., 1908.) Price 400 milliemes.

NOTES.

DR. A. BREINL, who has worked in connection with the Liverpool School of Tropical Medicine for the past five years, has been appointed director of the newly founded School of Tropical Medicine in Western Australia.

PROF. WILHELM VALENTINER has resigned the directorship of the Astronomical Institute of the grand ducal Observatory of Heidelberg. This institution is now merged with the Astrophysical Institute, under the general direction of Prof. Max Wolf.

LIEUT.-COLONEL ALLAN CUNNINGHAM, R.E., announces the verification of a Mersenne's number (the lowest as yet unverified) to be *composite*, viz.

$$2^{71}-1=228479.10334355636337793.$$

The nature of the large factor has not been determined.

THE death is announced in *Science* of Prof. S. W. Johnson, emeritus professor of agricultural chemistry in Yale University, where he held a professorship for fifty-three years. He had been a member of the National Academy of Sciences since 1866, had served as a past-president of the American Chemical Society, and was eminent for his contributions to agricultural chemistry.

THE Tuberculosis Exhibition which was held at the Art Gallery, Whitechapel, with great success (see NATURE, July 8, p. 48)—more than 70,000 people visiting it—has been moved to the Imperial International Exhibition (White City), Shepherd's Bush, and was opened there on Friday, August 6, by Lord Balfour of Burleigh. We understand that the organisers have already enough invitations to take the exhibition to the various districts of London and the provincial cities to keep it occupied for quite a year.

THE Cracow Academy of Sciences has awarded the Nicolas Copernic prize, amounting to 1000 crowns, to M. Jean Krassowski, of Cracow, for his treatment of the question, "A l'aide de la méthode de M. A. Schuster, examiner la question si les périodes des variations des latitudes, indiquées par MM. Chandler, Kimura, &c., sont réelles ou non." The Constantin Simon prize, of 900 crowns, for a work in the Polish language on mathematics or physics, has been adjudicated to M. Stanislas Zaremba, for his book "Exposé des premiers Principes de la Théorie des Nombres entiers."

THE British Museum (Natural History) has obtained from Mr. C. H. Sternberg a series of remains of the large dinosaurian Trachodon, from the Laramie Cretaceous formation of Wyoming, of which an account was pub-

lished in our last number. They have just been placed on exhibition in the gallery of fossil reptiles in a case near the remains of Iguanodon, with which it is interesting to compare them. Besides portions of skulls, jaws, teeth, and limb-bones, there are also fragments of the remarkable skin-impressions which have been described by Prof. Osborn.

IT may be remembered that the late Mr. Harry Barnato left by will the sum of 250,000*l.* for the purpose of founding some charity in the nature of a hospital, or kindred institution, in commemoration of his brother, Mr. Barney Barnato, and his nephew, Mr. Woolf Joel, both of whom died before him. After full and careful consideration of the merits of the many schemes put before them for the disposal of the money, the trustees have now decided upon applying it to the building and endowment of an institution for the reception of cancer patients. With the view of increasing the potentialities of the bequest, the new institution will be administered, except as regards its finance, in connection with the Middlesex Hospital, and the trustees have procured a suitable site in Nassau Street, adjoining this hospital's special cancer wards. The trustees, with Prince Francis of Teck, Lord Cheylesmore, Sir John Purcell, K.C.B., and Mr. Felix Davis, will form the committee which has been entrusted with the task of putting in train and carrying out this project.

THE Rev. F. St. John Thackeray, vicar of Mapledurham, gives in the *Spectator* of April 7 a few interesting stanzas from Tennyson's works to show the poet's appreciation of scientific truth. Tennyson and Darwin were born in the same year, and they did not meet until 1868, but many years previously the poet wrote the words, "So careful of the type she seems, So careless of the single life." Here, it is held, there is a suggestion of the principle of natural selection; and in other poems written before Darwin's work appeared there are anticipatory expressions upon the development of living organisms from simple to more complex forms "Till at last arose the man." Mr. Thackeray points out that Lord Tennyson says in his notes in the Eversley edition, "My father brought 'Evolution' into poetry. Ever since his Cambridge days he believed in it." It must not be forgotten, however, that the idea of evolution, as opposed to the doctrine of special creation, has been under discussion for quite twenty-four centuries. Greek philosophers, with their natural curiosity, considered the problem in detail; and six hundred years before the commencement of our era the idea of the marine origin of life was put forward by Thales. But recognition of the process of evolution is quite a different matter from the discovery of the cause. So far as we read Tennyson's lines we find in them no clear anticipation of Darwin's views as to variation and natural selection being the prime factors of organic evolution. Mr. Thackeray's letter shows that Tennyson was familiar with the general principle of development, but it provides little evidence that he anticipated the principle formulated by Darwin.

AN interesting piece of antiquarian work has just been completed by the Essex Field Club by means of a grant from the Essex County Council. It appears that in the time of Charles I. so much of this country had become "afforested" that the inhabitants of those districts subject to forest law found the conditions so burdensome that relief was applied for and sanctioned by the King, who authorised the restoration of the boundaries of all the forests to what they had been in the twentieth year of the reign of James I. This Act was passed in 1640, and in compliance therewith a court of inquiry was held at Stratford in 1641 in order to fix the boundaries of the Waltham Forest, an area comprising the forests known subsequently as Hainault and Epping. The Perambulation resulting from this "inquisition" set forth very explicitly the limits accepted by the commissioners. In defining these boundaries, natural features and the main (Roman) Colchester road were adopted for the western, northern, and southern limits respectively, but on the eastern side, where no well-defined natural or artificial features existed, certain stones, named and dated, were put up. In 1894 these long-forgotten boundary stones were re-discovered and identified by Prof. Meldola, who published a paper about them in the *Essex Naturalist* in 1895. The stones had been badly treated in later times, as several had been uprooted, and were found in ditches near their original sites. Last year the matter was formally brought under the notice of the Essex County Council, which body authorised the re-erection of the stones by the club at a cost not exceeding 100*l.* The work has now been completed, and a meeting of the club and of representatives of the County Council went over the district on July 31. Out of eight stones seven have been identified with certainty, and the site of the eighth has also been marked. The stones have been set in solid concrete beds, and an appropriately inscribed tablet let into the foundation of each. The Essex Field Club is to be congratulated in having rescued from complete oblivion this chapter in the history of a district the greater part of which is rapidly becoming covered with the bricks and mortar of the modern builder. The forest in 1641 began "at the Bridge of Stratford called the Bow."

WE learn from the *Revue scientifique* that an International Congress on Radiology is to be held in Brussels in 1910.

IT is stated that the Museum of Natural and Physical Science at Barcelona was destroyed during the riots in that city on July 28.

WE have received the first number of a journal published at Skagen under the title of *Fiskerhøjskolens Beretning*, and devoted to the schools which have recently been established in various parts of the country for instruction during the winter in all matters connected with fisheries.

IMITATION in monkeys forms the subject of an article by Mr. M. E. Haggerty in the August number of the *Century Magazine*. The monkeys experimented upon exhibited five phases of imitative behaviour, summarised as (1) simple arrest of attention; (2) following; (3) reaction to locality; (4) reaction to an object; and (5) exact repetition in detail of an observed action. By No. 1 is meant the watching by one monkey of the action of others, or, in other words, "looking," while No. 2, or "following," indicates a higher grade of mental action, and so on through the series.

ACCORDING to the report for 1907–8, the collections in the Transvaal Museum are increasing so rapidly that the accommodation afforded by the present building is altogether inadequate, this being notably the case with the mounted specimens of large mammals, of which a considerable number was added during the year under review. In the study collections the congestion is even worse, and as these include a great number of rare, and in certain instances unique, specimens, the urgent need of extension is evident.

THE Borough of Maidstone has issued an excellent and well-illustrated guide to the local museum and art-gallery, with a history of Chillington Manor House, in which the natural-history collections are preserved. Special attention is devoted in the museum to the local fauna, both recent and extinct, notices of various groups of which are given by local naturalists and geologists. The illustrations include photographs of the type-specimen of *Chelone benstedi*, a local Chalk chelonian now in the British Museum, and of part of the cranium of *Odontopteryx toliapica* from the London Clay of Sheppey, preserved in the Maidstone collection, the only known specimen of that remarkable bird except the type.

THE all-importance of selection to breeders and, in perhaps a somewhat smaller degree, to plant-growers (where hybridisation comes more largely into play), is universally admitted, but difficulties arise in practice when, as is generally the case, it is desired to improve more than a single characteristic of the animal or plant under experiment. As an aid in overcoming these difficulties, Messrs. Pearl and Surface, in the July number of the *American Naturalist*, suggest the adoption of a system of "selection index numbers," the idea of which is to combine in a single numerical expression the values of a series of important characteristics, all of which a breeder may be desirous of improving simultaneously. The analytical expression of this idea is discussed in the article, with illustrations drawn from maize and poultry raising, and it is thus shown that the index numbers form a valuable adjunct to the score-card in judging stock.

TWO notes on the feathers of kalij pheasants (Gennæus) are communicated by Prof. A. Ghigi to vol. xii. of the *Rendiconto* of the Royal Academy of Sciences of the Institute of Bologna, the first of these relating to a case of mutation in *Gennaeus swinhoei*, while the second is devoted to the development of the secondary sexual characters in *G. argentatus* and certain other birds. In the case of Swinhoe's kalij, certain marked variations from the normal type made their appearance in the feathers of a bird born in captivity, and as these cannot be attributed to hybridism, they are regarded as an instance of true mutation. In the second note the variations from the normal type of colouring and pattern produced in the feathers of the silver-pheasant and its hybrids by accelerated and retarded development are described and figured, and their bearing on the production of secondary sexual characters discussed.

FROM among a number of articles on natural history and geological subjects forming the second part of the fourth volume of *Aus der Natur*, we select for notice one by Prof. O. Jaekel on a new "find" of Devonian vertebrates between Cassel and Marburg, which has already yielded some very interesting remains, and is likely to produce many more in the near future. From this deposit, which is especially rich in armoured "placoderms," remains of no fewer than sixty different species of fish and fish-like vertebrates have been obtained, mostly in a wonderfully fine state of preservation, five or six of these belonging to forms previously known only by small portions of the armour. The author gives a restoration of the external form of Coccosteus, based on the new material, and differing very widely from the one in Dr. Smith Woodward's "Catalogue of Fossil Fishes." As now restored, the creature has four paired fins, a low but long dorsal fin, with a gap above the interval between the paired fins, and a somewhat similar ventral fin, continued along part of the long, whip-like tail, this long, slender tail being hypothetically added from evidence supplied by Dr. Traquair. In conclusion, Dr. Jaekel remarks that the most noteworthy feature in the new deposit is the occurrence of the remains of a number of forms of placoderms in one spot, whereas in other places only a few such are found in association. It indicates, in the author's opinion, a kind of "explosive development."

WE have often been surprised at the curiously unscientific, but unfortunately very common, use of the term "ovum" by medical writers to designate a human embryo which has developed very far beyond the unicellular condition to which alone the term ought to be applied. We believe that a certain section of the medical profession is apt to question the importance of preliminary scientific education, but the short time spent by the medical student over his elementary biology would not be wasted even if it did no more than give him some idea of accurate terminology. The immediate occasion for these remarks is afforded by a paper by Maximilian Herzog in a recent number of the *American Journal of Anatomy* (vol. ix., No. 3), in which the author describes a very young human embryo, closely resembling that known as "Peters' ovum." Our information as to the early stages in the development of man is, from the nature of the case, so extremely meagre that any fresh light on the subject will be welcomed by embryologists. The embryo in question is regarded as representing the earliest stage of normal human development hitherto known, perhaps from one to two weeks after fertilisation.

THE Bulletin of the Liverpool School of Tropical Medicine, of which the first number has just been issued, contains correspondence relating to malaria and mosquito reduction at Ismailia and Helouan. At Ismailia the expense of the anti-malaria measures has averaged 18,000 francs per annum. In 1903 malaria cost the Suez Canal Company 38,200 francs; in 1908 this item dropped to 16,800 francs.

WE have received the second number of the *Eugenics Review* (i., No. 2, July), published quarterly by the Eugenics Education Society. The contents include editorial notes and reviews of books, and articles by Sir Francis Galton, Mr. John Russell, Miss A. H. P. Kirby, and others. The review cannot fail to be both interesting and instructive to all those who have the welfare of the race at heart.

NICOLLE and Adil-Bey in 1902 reported that the infective particles of cattle-plague virus would pass through the Chamberland porcelain filter "F," and their results were confirmed by Yersin. E. H. Ruediger states (*Philippine Journal of Science*, iv., 1909, No. 1, p. 37) that he was not able to verify these results, and in a second series of experiments, using four different filter candles, confirms his previous work, no filter candle having been found to allow the cattle-plague virus to pass through.

IT is a usual custom in pharmacological work to state the dosage of drugs as so much per kilogram of body-weight of animal or man, the subject of experiment or treatment. Prof. Benjamin Moore points out in the *Biochemical Journal* (iv., Nos. 5, 6, and 7, July) that this method of stating dosage is inaccurate, the dose of a drug for two individuals of different size, apart from peculiar idiosyncrasies, being proportional, not to their weights, but to their *body surfaces*, in other words, to the two-thirds powers of their weights. Thus an adult of 150 lb. weight cannot be given fifteen times the dose for an infant

of 10 lb., but much more nearly a dose only six times as much. It may be that it is this principle which limits the value of some drugs. Thus atoxyl will cure trypanosome infections in mice and rats, but in cattle, horses, and man it is much less effectual. A rat of 140 grams weight can be safely given 0·02 gram of atoxyl. If the dose were proportionate to the body-weight, a man ought to be able to tolerate 10 grams, but, as a matter of fact, about 1 gram is the maximum safe dose, which is in close correspondence to the two-thirds powers of the ratio of weights (1/500).

THE progress of forestry in the University of Cambridge is briefly summarised in the second annual report of the forestry committee issued recently. It is announced that Mr. H. J. Elwes has made an offer to provide 1000*l.* towards the erection of a building to serve as a museum and a laboratory, where special attention would be devoted to the study of home-grown timbers. The reader in forestry, Dr. A. Henry, has taken steps to test the suitability of the western larch, *Larix occidentalis*, a native of North-west America, for planting as a forest tree in the British Isles and Europe; the canker disease of the common larch is being made the subject of systematic experimental investigation by Mr. E. R. Burdon.

HORTICULTURAL and general botanical articles form one of the leading features of the *Country Home*. The August number contains a contribution by Mr. G. C. Nuttall on plant aspects and plant names, in which, by means of a few examples and clever illustrations, the author shows the reasonableness of popular floral names; it is suggested that the subject is a suitable one for investigating during a holiday. A practical article on tomato culture is provided by Mr. F. W. G. Blyth, where again the excellent reproductions from photographs are conspicuous, and Mr. W. L. Térasse gives advice on the intensive cultivation of strawberries. The monthly calendar and special instructions for the month's work in garden and greenhouse add to the value of the publication.

OWING to loss of the paper for printing, the early numbers of the *Philippine Journal of Science* for the current year have been delayed. The first botanical number opens with a contribution, by Dr. E. B. Copeland, on the ferns of the Malay-Asiatic region. Largely in connection with the identification of specimens from the Philippines, Dr. Copeland has acquired a knowledge of the ferns of the Malay Archipelago, which has induced him to present a fern flora of this region. This first part refers to ten families, from the Ophioglossaceæ and Marattiaceæ to the Cyatheaceæ. Keys and short diagnoses are given for each family, genus, and species. The most striking innovation is the reduction of the genera Alsophila and Hemitelia to Cyathea. Cyathea thus becomes a genus of about 400 species, of which one-fourth occur in the region under consideration; Dicksonia and Balantium are retained. Under Marattiaceæ a fifth genus is provided by the author's monotypic genus Macroglossum, and Kaulfussia is lost under the synonym Christensenia.

MR. W. J. BEAN contributes to the current number of the *Kew Bulletin* (No. 6) a note regarding the effect of the past winter on trees and shrubs in Kew Gardens, with special reference to plants of recent introduction. It is pointed out that alternations between cold and unseasonable warmth were more potent than the actual intensity or duration of cold, and, incidentally, it is noted that plants growing in low, damp situations were killed, while specimens situated on drier ground survived. A considerable number of recently introduced Chinese plants, including *Davidia involucrata* and *Ailanthus Vilmorinii*, came successfully through the ordeal, and the author gives a list of rhododendrons from north India that may be considered hardy. Bamboos suffered greatly, with the exception of *Arundinaria nitida* and *A. fastuosa*. Other shrubs that proved hardy are *Erica stricta, Cistus laurifolius, Genista virgata,* and *Vaccinium padifolium*.

THE Bulletin of the College of Agriculture, Tokyo Imperial University, Japan, vol. viii., 1909, No. 2, contains a paper by S. Kusano on the cytology of *Synchytrium puerariae* and *S. decipiens*, parasitic fungi belonging to the phycomycetes, with bibliography, and illustrated with several excellent plates; a description of a new species of moth belonging to the genus Latirostrum, by T. Miyake; and a revision of Japanese Arctianæ, insects injurious to farm crops and fruit and forest trees, by the same author, with descriptions of some new species.

A SERIES of Bulletins, Nos. 141–4, issued from the Colorado Agricultural College, deal with various phases of market-garden work. No. 142 discusses general problems such as tillage, manuring, &c., in the light of local experience, and lays stress on the conditions which must be fulfilled in Colorado if success is to be attained. Among them is the necessity for "shade" crops, *i.e.* for crops grown with the view of shading the ground from the sun's heat, or, in winter, of reducing the loss of heat by radiation, and thus of keeping the soil temperature more uniform. Another effect of a "shade" crop in summer is to diminish loss of water by evaporation. The other bulletins deal with special crops—grapes, cabbages, and celery.

SOME of the most important agricultural problems of Cape Colony are associated with water supply, and that this fact is recognised is abundantly proved by the number of articles devoted to it in the Agricultural Journal of the Colony. The Karoo is a dry region, and at the same time possesses a very rich soil; this combination is not unusual, and can be paralleled in the dry belt of British Columbia, of parts of the United States, and elsewhere. Its productiveness is limited by the water supply, and recourse is had to various methods for conserving and increasing the amount of moisture in the soil. Special methods of cultivation are found to diminish loss of water by evaporation, and dams are built to store rain-water, which can then be used for irrigation. Attention is also being directed to the effect of forests on water supply.

THE *Bulletin de la Société d'Encouragement pour l'Industrie nationale* (vol. iii., No. 3) recently published a long and interesting article by M. Hitier on agriculture in Russia. The various regions are described, and a good account is given of the black soils, the steppes, and other well-marked types of soil. Analyses are quoted showing the presence in black soils of 0·5 per cent. of nitrogen, 7 per cent. of organic matter, and distinct quantities of carbonates, along with sufficient potash and phosphates; the area covered by these wonderfully fertile soils is considerably larger than that of France. The natural conditions are eminently favourable for agricultural development, but the economic conditions, especially the collective ownership of land and the power of the Mir, are regarded as great obstacles, and the author does not consider any advance possible until these artificial hindrances are removed.

THE movements of the deeper waters of the Skagerack form the subject of an interesting paper by Dr. O. Pettersson which is published as No. 47 of the *Publications*

de Circonstance of the Conseil Permanent International pour l'Exploration de la Mer. Dr. Pettersson finds that in the underlying deep waters there is a tidal oscillation which can have daily, monthly and annual periods. These oscillations produce variations in the temperature and salinity of the sea at certain depths, and their investigation becomes of great commercial importance owing to their action in determining the coming and the migration of the herring shoals. The great annual oscillation of the coastal water in the Norwegian sea shows amplitudes of more than 100 m., and the corresponding expansion of the coastal waters of the surface to the westward, in the summer months, was found by Hjort and Nansen to cover an area more than 100 miles broad.

THE fourth report on earthquakes in Jamaica, by Mr. Maxwell Hall, contains a catalogue of shocks recorded since the commencement of the weather service in 1880, and some interesting particulars regarding the fracture of cables by the earthquake of January 14, 1907. The cable to Colon was broken four miles south of Bull Bay, and to the south of the break the cable was so deeply buried in mud that it parted in the attempt to raise it. A more extensive break took place at twenty miles further south, where the cable had been dragged from west to east, and the fractured ends were fully a mile apart, and further south the cable was again buried in mud and had to be abandoned. Captain Morrell, of the repairing ship *Henry Holmes*, reports that the two ends of the cable fitted together perfectly, the cable was in perfect condition, there were no signs of erosion, and the wires were broken clean as by a tremendous strain, which he considers to have been produced by a landslide from the direction of the shallow water to the deeper. Mr. Hall points out that the soundings indicate a gradient of 740 fathoms in five miles, or about 1 in 6, on the average, from the California bank, but where the great break occurred the sea-bed is apparently level or nearly so; consequently, he considers, the dragging of the cable for a mile or so to the east, and the parting of the ends to the same extent, could only have been produced by a great chasm opening in the bed of the sea to the east of the great break.

THE first part of the "Bergens Museums Aarbog" for the current year records an important discovery at Jaederen of a house of the Middle Iron age. It consisted of a single oblong room, the roof resting on beams set upright, distinct marks of which were found in the clay floor, and the interior being filled with remains of the birch-bark roofing. The fireplace was a paved depression in the centre, but fires had been made also in other parts of the apartment. The antiquities discovered were, on the whole, disappointing, consisting mainly of earthenware pots and grindstones, of which illustrations are given in the report. This discovery is notable, because this is the first house of this type which has been found in Norway; but in Sweden they are well known in Gotland, Oland, and Uppland, and they seem to have been noticed in Finland.

PROF. JUNE DOWNEY contributes an article on muscle reading to the July number of the *Psychological Review*. By muscle reading is meant that well-known communication between one person, the guide, and another, the subject, by means of involuntary movements of the guide, when his attention is riveted in a given direction. The writer contends that concentration of the guide's attention not only induces free involuntary movements, but also leads to more complex forms of "automatic" activity. For instance, although the guide's attention may be momentarily distracted, his involuntary movements persist unaltered. Or, again, despite his concentrated attention in a given direction, his movements may have reference to a preceding test instead of to the present one. Unfortunately, the scant experimental data given in the present paper and her defects of experimental method make it difficult to accept with confidence any of the writer's interesting conclusions.

DURING a stay at the Sonnblick Observatory (3106 metres) in July, 1908, Dr. A. Wagner, of the Austrian Meteorological Office, made some interesting observations on cloud elements, the results of which are published in the *Sitzungsberichte* of the Vienna Academy for December last. The author deals with the water contents, both in the gaseous form, as shown by the hair hygrometer, and in its fluid form in drops or ice-crystals, also with the size of the drops. During thick fog the humidity was generally more than 100 per cent., and only sank below that amount when the sun became visible through the fog. The mean of the measurements of the fluid contents of the clouds was about 2 grams per cubic metre; the greatest value was 4·84 grams, and the smallest 0·12 gram. The total of the fluid and gaseous contents varied between 9·98 grams and 4·17 grams per cubic metre; the fluid contents were always less than the gaseous. Visibility was found to be inversely proportional to the fluid contents; its dependence on the size of the drops could not be determined, owing to the few measurements made of the latter. The mean diameter of the drops, determined by the optical method, was 33 μ, but only eighteen such observations were made, on three days.

THE July number of the Journal of the Röntgen Society contains a paper by Dr. G. H. Rodman on the historical collection of sixty-three Röntgen-ray tubes which has been got together by the society, and is now in the possession of the authorities of the Victoria and Albert Museum at South Kensington, and will in a short time be installed in two show-cases in the museum. The paper is well illustrated by photographs of the tubes, and will be of great use to those who are unable to pay a visit to the museum to inspect the tubes themselves.

A VALUABLE report by Dr. H. Happel on the present position of our knowledge of the properties of the monatomic gases is to be found in the *Physikalische Zeitschrift* for July 15. The author, after giving an account of the theoretical advances made by Sutherland and by Reinganum on the assumption of hard spherical molecules, refers to the older work of Maxwell and Boltzmann, based on the molecules repelling each other according to the inverse fifth power of their distance apart. He shows that the experimental work done during recent years on the viscosity, heat conduction, and diffusion of the simpler gases does not provide more than general support for any of these theories, and that there is great need of further investigation of these properties over very wide limits of temperature. The theory of the gas-liquid state and the theory of binary mixtures as stated by van der Waals have, in Dr. Happel's opinion, proved valuable weapons in the hands of those who, like Ramsay, Travers, Dewar, and Kamerlingh-Onnes, have been engaged in investigating the thermal properties of the monatomic gases and of mixtures of them.

A PAPER on refrigerating installations, with special reference to the arrangements necessary when narrow limits of temperature are required, was read by Mr. Robert Balfour at a meeting of the Institute of Marine

Engineers held at the White City on July 24. The author's references to the difficulties of dealing with beef are particularly interesting. Beef is much more difficult to keep in condition during a voyage than mutton. The temperature must never be low enough to produce solidification; such would cause the substance of the meat to burst, and on thawing the meat would have a flabby appearance, which would depreciate its value, although perfectly wholesome as food. The temperature should be maintained as nearly as possible at 29·5° F. The animals must not be excited immediately preceding slaughter, or have any sprained joints which would produce decomposition of the joint oil. The atmospheric conditions must not be thundery or sultry at the time of slaughter, or the air heavily charged with moisture, and scrupulous cleanliness must be observed throughout. Indeed, the ideal conditions for the slaughter-house should be those of the operating theatre of a modern hospital. An article in *Engineering* for July 30 states that there has not hitherto been much success in the bringing of chilled beef from Australia, but an experiment is now being made with a large consignment, and will be watched with interest.

IN the recently issued report of the proceedings of the International Committee of Weights and Measures at its meeting held in March last, the following points are of interest. Investigations made at the bureau of the committee at Sèvres have shown that when water at temperatures between 6° C. and 8° C. is saturated with air, the density of the water is diminished by about three parts in a million. Vols. xiv. and xv. of the *Travaux et Mémoires* of the committee, which are expected to be published shortly, will include the researches of M. Chappuis on the above subject, and also an account of the experiments conducted by MM. Benoît, Fabry and Perot with respect to the length of the metre in terms of wave-lengths of light. The former volume will also contain three important memoirs on the mass of a cubic decimetre of water. The committee announces the adhesion of Chili and Uruguay to the metric convention, and expresses much satisfaction with the proposal of our Colonial Office to distribute copies of the convention to all the British colonies and dependencies. The report includes two appendices by M. Guillaume. The first is a supplement to his paper entitled "Récents Progrès du Système métrique," which was presented to the general conference of weights and measures in 1907, and the second gives an account of the present state of the question of standard end-measures of length. It would appear from the latter paper that Airy's method for determining the lengths of end-bars, which had almost fallen into desuetude, has recently been employed at the International Bureau with considerable success.

THE issue of the *Chemist and Druggist* for July 31 celebrates fittingly the attainment of our contemporary's jubilee. The occasion of the annual summer issue of the magazine has been taken to publish a history of the growth of the periodical from its modest beginning in 1859 to the important technical journal it has since become. The contents of this jubilee issue remind us that the *Chemist and Druggist* has for many years given prominence to the scientific aspects of pharmacology, and has insisted consistently upon the value of a knowledge of pure science if scientific principles are to be followed successfully in technical processes. The present issue contains, in addition, an exhaustive account of the proceedings at the annual meeting of the British Pharmaceutical Conference, held at Newcastle-on-Tyne towards the end of last month.

A LIST of the lectures arranged for the session 1909–10 in connection with the extension section of the Manchester Microscopical Society has reached us. The purpose of this section is to bring scientific knowledge, in a popular form, before societies unable to pay large fees to professional lecturers. The lectures are given gratuitously by members of the society, and all fees paid for lectures are devoted to the working expenses of the section. In addition to lectures, the honorary secretary is willing to arrange practical demonstrations in microscopy, microscopical exhibitions, and the mounting of microscopic objects, in connection with the work of natural history societies in the neighbourhood of Manchester. It is noteworthy that there are about sixty lectures from which to choose. The honorary secretary is Mr. R. Howarth, 90 George Street, Cheetham Hill, Manchester.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF SATURN'S RINGS.—It will be remembered that on the occasion of the disappearance of Saturn's rings in 1907, Prof. Barnard, and other observers, found that even when the rings were at minimum visibility there still remained bright condensations on either side of the planet. These, Prof. Barnard suggested, were possibly due to the sunlight sifting through and being reflected from the particles comprising the crape ring.

Observations made during 1908 tend to confirm this hypothesis, for, when seen very obliquely, the crape ring appeared much brighter than when seen at such times that the rings are more open, thus showing that the particles are probably but sparsely disposed, and would permit of such transmission and reflection of sunlight as was suggested. The relative apparent brightnesses of the inner and outer bright rings as seen at different epochs also change, for during 1908, when the foreshortening of the rings was great, the outer ring appeared to be the brighter. Prof. Barnard suggests that if we could look normally at the surface of the rings the outer one would be relatively dark, and the crape ring, perhaps, invisible. Although careful search was made for it, Prof. Barnard was unable to detect any trace of the outer dark ring discovered at Mount Revard, and subsequently observed at Geneva and Greenwich (Monthly Notices [R.A.S.], vol. lxix., No. 8, p. 621).

THE RELATIVE ATMOSPHERIC EFFICIENCY OF TELESCOPES.—In a letter to No. 411 of the *Observatory* Mr. R. T. A. Innes directs attention to the subject of the relative efficiency of telescopes of different apertures as compared with the theoretical efficiencies. By tabulating the results obtained by Burnham, with various apertures, he shows that if the efficiency of the 36-inch Lick refractor be taken as 1·0, that of the 6-inch refractor used by Burnham is, relatively, 2·5, the efficiency per inch of aperture apparently decreasing regularly as the aperture increases.

This phenomenon is attributed by Mr. Innes to atmospheric interference; with a large instrument it is more difficult to find a night with perfect definition, and it is only on such nights that close doubles, at the limit of the observer's vision and the telescope's power, can be observed.

THE MOTION OF THE POLE.—No. 4344 of the *Astronomische Nachrichten* contains a paper by Mr. H. Kimura discussing the polar motion and the z component during the period 1890·0–1908·5. The investigation of the fourteen-months' period shows that it changed rather quickly, being 436 days in 1893, 442 days (maximum) in 1897, and 427 days in 1907. No such abrupt change of amplitude accompanied this change of period.

The new discussion is opposed to the previous theory that the annual period varies quickly while the fourteen-months' period remains nearly constant, the opposite appearing to be the case; but, as Mr. Kimura points out, the problem is a complicated one, in which many variables are inherent, and will have to wait for further observations and study before any definite conclusions are arrived at. Special attention must be given to the effect of lati-

tude, and it may be found that the slow variation of the z component, especially in phase, is not unconnected with the sixty, or seventy-five, year period of the annual term which was announced by Dr. Chandler.

REPORTS OF OBSERVATORIES.—Mr. Hough's report of the work done at the Cape Observatory during the year 1908 cannot be summarised effectively in a brief note, but one or two points may be especially recorded. The Victoria telescope was in use on 165 nights to secure 601 stellar spectra for line-of-sight determinations; the solar parallax programme having been completed in May, the spectrograph was dismounted, repaired, and adjusted, and is now employed in the determination of the radial velocities of 365 stars between declination 30° N. and the south pole. The value obtained for the parallax was $8{\cdot}800'' \pm 0{\cdot}006''$. The astrographic telescope was employed in taking proper-motion and parallax plates of some of Prof. Kapteyn's "selected areas."

In the report of the Paris Observatory for 1908 M. Baillaud outlines the re-organised programme of the observatory work. Among other things, we note that the small equatorial *coudé* is to be employed, by M. Hamy, for the study of sun-spot spectra.

SOLAR RESEARCH.—In the August number of the *Observatory* Mr. A. A. Buss discusses, at some length, the possible purport of the results obtained in recent solar research, dealing principally with appearance of the D_3 line of helium. In concluding, he states that he has, on a number of occasions in recent years, seen immense "dark" hydrogen clouds projected on the dark background of the sun's surroundings; this phenomenon he attributes to the projection of the clouds against the slight luminosity of the sun's hydrogen corona.

A BRILLIANT METEOR.—Observing at Marseilles on June 26, M. Borrelly saw a splendid meteor, which appeared at 14h. 0m. 56s. (Marseilles M.T.), and illuminated the whole of the sky for some three seconds. The light was extraordinary, and the meteor travelled from Pegasus to the Dolphin, above ϵ Pegasi, in a N.E. direction (*Astronomische Nachrichten*, No. 4339).

PHYSIOLOGY AT THE BRITISH MEDICAL ASSOCIATION.

THE chief points of general scientific interest in the proceedings of the British Medical Association at Belfast are to be found in the communications read in the sections of anatomy and physiology, bacteriology and pathology, on July 28–30. The following account is practically limited to a brief summary of Prof. Sherrington's presidential address to the section of anatomy and physiology, entitled "The Deep Afferents—their Distribution and Function."

In contrast with our considerable knowledge of the surface afferents, our knowledge of the deep afferents is relatively slight. The deep afferent system may be subdivided into a visceral and a muscular portion, using the latter term in a somewhat wide sense.

From one point of view the visceral portion may be regarded as superficial with reference to the lining membrane of the alimentary canal and respiratory passages, but practically this fact may be neglected. The consciousness of the body is normally almost entirely confined to the external surface. When we take food, it normally disappears from our ken after its passage through the fauces, and consequently if we were guided only by our own consciousness we might doubt the likelihood of the existence of visceral afferents associated with sensation. Yet numerous examples of dim visceral sensations, especially gastric ones, might be adduced. For example, after drinking hot fluids a characteristic gastric sensation is produced. Under pathological conditions numerous visceral sensations may be obtained. The explanation and localisation of the latter form a fruitful field, in the investigation of which physiologists, anatomists, and clinicians might usefully combine. Further, it has long been recognised that afferent nerves are not necessarily associated with sensation. Numerous examples of this fact will be given in the course of this account.

The mouth and nasal cavities form an intermediate field between the external surface of the body supplied by the superficial afferents, and the remainder of the alimentary canal and the respiratory passages supplied by the deep visceral afferents. In this region the nature of the effective stimuli alters. Whereas mechanical and physical stimuli are specially effective when applied to the external surface, chemical stimuli, both gustatory and olfactory, become specially effective in the intermediate zone both in the direction of yielding sensations and of inducing reflexes.

Prof. Sherrington next passed from the consideration of this intermediate field to that of the deep visceral afferents proper. Formerly, gastric and intestinal movements and digestion were believed to be controlled by mechanical and chemical stimuli affecting afferent visceral nerves. More recently a deeper insight into the mechanism controlling gastric and intestinal movements and digestion has revealed a number of difficulties which militate against the acceptance of the older views. For example, the intestinal movements, both the simple pendular and the more powerful and less frequent peristaltic movements, take place in an isolated loop of intestine after section of all the nerves passing to the loop. In this case there cannot only be no conscious reaction, but even no true reflex act. Further, the removal of the abdominal sympathetic in the dog does not cause any obvious alteration in digestion or intestinal movements. Under such conditions the regulation of movements and digestion is controlled by the intrinsic nerve mechanism of the alimentary canal, namely, Auerbach's and Meissner's plexuses.

A very interesting phase of recent physiology is the suggestion by Bayliss and Starling of a mode of chemical regulation other than that through the nervous system. They have extracted from certain organs substances called hormones, which are capable of exciting the activity of correlated organs. One of the best known of these is secretin. Bayliss and Starling showed that secretin is effective after severance of nervous connections, and have thus rendered doubtful Pawlow's view that the co-adjustment of organs is mainly nervous in origin. Other examples of hormones are a substance extracted from the cardiac end of the stomach, which acts on the pyloric end, and carbon dioxide, which may be regarded as the hormone affecting the bulbar respiratory centre.

Prof. Sherrington next passed to a subject of great theoretical and practical interest, namely, visceral pain. This subject has long formed a field of controversy, largely on account of the obvious difficulties in the way of its investigation. The observations which have been made on visceral pain are best dealt with in historical sequence.

Haller, one of the earliest investigators of this subject, distinguished parts which feel from those which do not feel. He included the viscera, tendons, and blood-vessels amongst the non-feeling parts. His results were largely obtained by investigation of the human subject, using interrogation of the patient as the test. He also experimented on animals. The methods of stimulation used in the latter cases were extreme in character, and consequently throw no light on the results which might be obtained by the use of more normal and adequate stimuli. Johannes Müller held views diametrically opposed to those of Haller. He maintained that the viscera are sensitive.

Amongst later observers, Head almost takes visceral pain for granted, and, following Ross, develops the idea of "referred pain." Lennander's papers are the most recent on this subject. As the result of experiments on man, he comes to the conclusion that the abdominal and thoracic viscera do not feel. The parietal peritoneum is also insensitive, but the subserous layer of the peritoneum is highly sensitive even under normal conditions. When slightly inflamed the subserous layer becomes hypersensitive.

Meltzer's results are opposed to those of Lennander. From a large series of experiments, chiefly on the dog, but also on man, he comes to the conclusion that stimulation of the liver and intestines elicits reactions that indicate pain. After a short period of exposure to the air, the viscera appear to become hypersensitive, slight stimuli producing well-marked reactions.

On considering the results obtained by these observers, it is difficult to imagine that the powerful vaso-motor re-

actions obtainable by stimulation of the abdominal sympathetic are not associated with sensation. The distinct reflex contraction of the abdominal muscles resulting from stimulation of the abdominal sympathetic is another reaction which it is difficult to believe is not associated with sensation. The latter phenomenon has a two-fold interest. In the first place, it is the basis of a well-known clinical symptom, the rigid belly wall, and, secondly, it represents a form of tonic contraction not directly inducible by artificial stimuli.

On examining critically Haller's, and to a less extent Lennander's paper, we are struck by the fact that the stimuli used are unnatural in character. It is not likely that the viscera are equally responsive to all forms of mechanical stimuli. Twisting, stretching, or squeezing the wall of the intestine from the outside may be ineffective, because the nerve endings in these organs are adjusted for stimuli of another kind. In the case of the bile duct and of the ureters a twist produces no vaso-motor effect, but distension by injection produces a well-marked rise of blood pressure.

The "referred visceral pain" was discussed next. Dr. J. Mackenzie denies that a viscus is ever directly painful, the pain felt being essentially a "referred one." For example, in pleurisy the lungs and parietal pleura are insensitive. While agreeing with Lennander in the view that the subserous layer of the pleura is sensitive, Mackenzie holds that the pain of pleurisy is mainly a referred pain due to cramp of the muscles of the thoracic wall. Mackenzie gives the following theory as to the mechanism of the different forms of "referred pain." He holds that stimulation of afferent visceral nerves by some influence increases the excitability of afferent centres in the cord connected with corresponding areas of skin. The pain is consequently referred to these cutaneous areas, and is only indirectly the result of stimulation of deep visceral afferents.

Head gives a somewhat different explanation. Impressed by the fact that inflammation of spinal ganglia produces herpes zoster, he was led to believe that afferent visceral fibres in their passage through the same ganglia as certain afferent cutaneous nerves can affect the adjoining cells connected with the latter and thus produce "referred cutaneous pain." This view is opposed to Müller's law, and was finally given up by Head. He ultimately transferred the seat of the nervous mechanism from the ganglia to deeper centres in the cord. The segments of the cord connected with "referred pain" do not correspond with the segments of the spinal axis as indicated by the ganglia. Head suggests that the "referred pain" areas correspond with the primitive phylogenetic segments of the cord. He leaves the mechanism of overflow unexplained. A remarkable fact is that the area of skin affected by referred pain is a mere patch or couple of patches, not a segment, but nevertheless more or less segmentally arranged.

The deep visceral afferents from the heart are not only those which have been most fully investigated experimentally, but also form an intermediate group between the pure visceral deep afferents and those of somatic or muscular origin. The chief afferent nerve of the heart is the depressor, and the receptive field for its stimulation is its nerve terminations in the wall of the aorta. The most adequate stimulus is distension of the walls of that vessel. The result of stimulation is a lowering of blood pressure due to a diminution of vascular tone. The nature of this tone, like that of voluntary muscles, is still obscure. It is doubtful whether stimulation of the depressor gives rise to pain directly. The areas of "referred pain" given by Mackenzie are not cranial, as we should expect, since the vagus is a cranial nerve, but mainly lie in the chest wall. Tender spots, however, are also found on the head.

Prof. Sherrington then gave a brief survey of deep non-visceral or muscular afferents. Since the work on this subject is largely due to himself, and since he has elsewhere stated his views more fully, it would not serve any good purpose to try to epitomise this part of his paper.

The paper was followed by an interesting discussion, in which Prof. J. S. Macdonald, Dr. Graham Brown, and others took part. The discussion chiefly referred to the nature and functions of the terminations of the deep afferent muscular nerves. A number of other papers of anatomical and physiological interest were also read by the following:—Prof. Dixon (Dublin), the development of the achondroplasic skeleton; Prof. Anderson (Galway); Dr. Dickey (Belfast), the cervical pleura; Dr. Johnston (Dublin), the intercostal nerves; Drs. Goodall and Earle (London), the structure of the pancreas in relation to its functions; Dr. Maclean (Liverpool), phosphatides in the light of modern research; Prof. B. Moore (Liverpool), the chemistry of hæmolysis; Dr. S. Spicer, some points in the mechanics of respiration; Prof. Thompson, the development of the fœtal heart; Dr. Leonard Hill, F.R.S., the influence of inhalations of oxygen on the onset of muscular exhaustion; Dr. Rutherford, some points in connection with the anatomy of the cranium of the fish; Dr. Waterston, some instruments used in anthropometry.

RECENT IMPROVEMENTS IN THE INTERNAL-COMBUSTION ENGINE.[1]

II.

WE have already explained how important in the economical development of the internal-combustion engine is an accurate and precise knowledge of the physical properties of the working medium. The two chief features of which a knowledge is required are the calorific value of the explosive mixture and the relation between the specific heat and temperature of the ignited gases. The calorific value has been carefully ascertained for most of the gases commonly used, but the specific-heat relation is still a matter of unfortunate uncertainty. At the Leicester meeting of the British Association in 1907, under the sectional presidency of Prof. Silvanus P. Thompson, the desirability of clearing up the doubts that surrounded this subject was so keenly felt that an important committee was appointed for "the investigation of gaseous explosions, with special reference to temperature." An account of the findings of this committee was published in NATURE of June 24 last. From our present point of view the important result of the committee's work is expressed in the following extract from its report:—"Recent researches on the properties of the gases at high temperatures have definitely shown that the assumption of constant specific heat is erroneous, and have given sufficient information about the magnitude of the error to show that it is of material importance. . . . The closer approximation to the real cycle which is made by taking account of the actual properties of the working fluid, though it leads to some complication of formulæ, gives compensating advantages of real practical value." This bears out, also, a remark made by the late Prof. Zeuner[2] to the effect that "at any rate there must be dropped from the theory of the internal-combustion motors the former assumption of the constancy of the specific heats of the products of combustion." A curve connecting the specific heat at constant volume (Cv) of the mixture of gases, formed by the explosion of one part of coal gas in nine parts of air, with temperature centigrade (θ), which was considered to be accurate within 5 per cent., was included in the committee's report. A formula which fits this curve closely is

$$C_v = 0{\cdot}172 + 0{\cdot}075\frac{\theta}{1000},$$

and although the constant in the second term on the right-hand side of this equation can only be looked upon as a first estimate, however carefully chosen, the equation does, probably, represent the high-water mark in our present-day knowledge, and from it can be deduced the limiting theoretical efficiency of engine cycles in which such a working medium is employed.

It is well known that on the basis of a constant specific heat the ideal efficiency (η) can be found from the following equation,

$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma - 1},$$

where r is the ratio of compression and γ is the ratio of the specific heats. This relation applies with equal truth

[1] Continued from p. 172.
[2] "Technical Thermodynamics," by Prof. Zeuner.

whether the cycle followed is (1) the constant-volume cycle, (2) the constant-pressure cycle, or (3) the constant-temperature cycle, an important discovery attributed to Profs. Unwin and Callendar. The problem now arises to re-calculate the thermal efficiency (η) for a working medium of which the specific heat is *not* constant. Most of the important internal-combustion engines operate on the constant-volume cycle, and if we re-calculate the equation to suit this case, making the necessary approximations to secure a workable result of sufficient accuracy, and using the above linear law based on the British Association Committee's figures for specific heats, we find that the new efficiency equals

$$\eta\left\{1-\frac{1}{4000}\left(\overline{1-\eta}\,.\,T_2+T_0\right)\right\},$$

where T_2 is the maximum absolute temperature (centigrade) in the cycle, T_0 the suction temperature, whilst η is the value obtained from the equation

$$\eta=1-\left(\frac{1}{r}\right)^{\gamma-1},$$

using here the value of γ corresponding to the *absolute zero of temperature*. The value of T_0 is practically independent of the compression, and in round figures suitable to this calculation may be written down as 400. The value of T_2 for a given richness of mixture will depend upon the degree of compression before ignition, and can be calculated therefrom. In this way a new expression for the real thermal efficiency can be obtained in terms, not of T_2, but of r, and the following table shows a few comparative figures worked out in this way. The figures for the "air-standard" efficiency are also given by way of comparison.

Thermal Efficiency.

Ratio of compression	"Air standard"	Real thermal efficiency (approximate figures)
4	0·43	0·30
10	0·60	0·45

Ratio, air/gas = 9/1.

It will be seen that in each case the real efficiency is about a quarter less than the "air-standard" efficiency.

This discrepancy sufficiently explains why those associated with the design and building of gas engines have expressed their dissatisfaction with the "air standard" of efficiency. The adoption of the "air standard" has led to the setting up as an ideal, to be aimed at and striven after, of a series of figures which it now appears are about one-third above the thermal efficiencies theoretically possible, and it is not surprising that engine builders, who from their practical work realised that there must be something wrong with the theory as then put forward, should have objected. It is not too much to say that had the engine builders to depend in the past solely on scientific guidance as the mainspring of their investigations, there would have been far less progress made than has been effected by the system of trial and error. Even now the state of knowledge as to gaseous specific heats is so uncertain that no accurate quantitative theory of the thermodynamics of the internal-combustion engine can be laid down. The writer has, however, endeavoured to show here and elsewhere how the problem may be investigated symbolically, and so prepared for expression in numerical form as soon as the thermal properties of the gases are actually known.

Mr. Dugald Clerk, in his 1907 paper [1] before the Institution of Civil Engineers, made some estimates of real efficiencies based on theoretical maximum temperatures of 1600° C. and 1000° C., and his results are given below.

	Ideal efficiencies		
r	If maximum temperature of cycle 1600° C.	If maximum temperature of cycle 1000° C.	On air standard
2 ...	0·195 ...	0·200 ...	0·242
3 ...	0·286 ...	0·293 ...	0·356
4 ...	0·354 ...	0·356 ...	0·426
5 ...	0·384 ...	0·394 ...	0·475
7 ...	0·439 ...	0·443 ...	0·541

It was apparently contemplated that these figures might be used in comparison with engine performances in which the *real* maximum temperatures were also 1600° C. and 1000° C. This, however, would be open to several objections. As an instance, take the case of an engine which by improved design was made capable of giving for the same mixture and the same compression ratio a higher maximum temperature and pressure. Such an effect might be produced, let us say, by decreasing the ratio of cooling surface to volume through an alteration in the amount of pocketing. This new engine, on the basis of comparison with an ideal cycle having an identical maximum temperature, would probably show little, if any, improvement in relative efficiency over the old engine. Such a result would tend to defeat the purpose for which comparisons with ideal cycles are made. It would seem to the author that the better way would be to compare both old and new engines with an ideal cycle having a maximum temperature corresponding to the known richness of the mixture, its calorific value, and the ratio of compression.

A factor that has affected most advantageously the recent progress of the internal-combustion engine is the great improvement that has taken place in engine indicators. The old moving lever design, although thoroughly serviceable for most steam engines and for many slow-moving internal-combustion engines, has been found entirely untrustworthy with modern high-speed internal-combustion engines. A new form of instrument has been devised in which the recording lever is a beam of light, which, having no inertia, has no time-lag. This vitally important improvement in the indicators was due, in the first instance, to the prescience of Prof. Perry,[1] and in its later stages to the experimental skill of Profs. Callendar and Hopkinson. The writer has recently calculated out the case of an indicator of which the free periodic time of oscillation was 1/300 sec., and has shown that explosions occurring even in so short a time as 1/200 sec. could be adequately followed and recorded. We believe that this oscillation period represents about the sensitiveness of one of the reflecting indicators used by Prof. Hopkinson at Cambridge, and the calculation serves to show how accurately the new instruments can be made to follow extremely rapid explosions.

It would be useless to base any deductions on the records given by one of the old type of instruments in such a sharp explosion as this. Errors of as much as 5 per cent. are now known to have occurred in the measurements of horse-power made by the old instruments. On the other hand, it cannot be denied that the older type was a great deal easier to handle, and that it could be used by comparatively untrained persons. The new reflecting kind, despite its accuracy of measurement to within 1 per cent. of the power, is rarely seen in workshops, and the measure of "indicated horse-power" has been very commonly abandoned in favour of the measurement of "brake horse-power" both in the case of large and small engines. In the case of the numerous small high-speed petrol engines, the practice of actually measuring brake horse-power is often replaced by the use of a rating formula giving a "nominal" horse-power. It seems at first sight extraordinary that there should be a reversion to the old unscientific "N.H.P.," but, despite their apparent similarity, the "N.H.P." of the old days of the steam engine and boiler, and the "rating H.P." of the modern petrol engine, are really based on very different considerations, and, as there appears to be every likelihood that the latter will be constantly revised with the aid of the best scientific advice possible, there is little real foundation for any scientific objection to it. The pioneer work done by Prof. Callendar in promoting this advance cannot be too gratefully acknowledged. Others have also worked at the problem since, and a considerable "output" of rating formulæ has resulted. That in most common use is $\text{H.P.}=\frac{D^2.N}{2{\cdot}5}$, where D is cylinder diameter in inches and N is the number of cylinders. This formula was put forward with the authority of the Royal Automobile Club, and experience has shown that in the great majority of cases it gives wonderfully good results. It may even be doubted whether any of the far more complicated

[1] Proc. I.C.E., vol. clxix., p. 145.

[1] "The Steam Engine," by Prof. Perry, p. 117.

formulæ since brought forward give a more accurate measurement. It is, of course, not fitted for use with racing motors, in which everything in design is sacrificed to piston speed, high mean pressure, and a sufficient endurance to last through a few races. For an engine having 4-inch cylinders the Royal Automobile Club formula gives a rating of 25·6 horse-power, which is about the brake horse-power that a normal engine of this size would yield when driven at a normal speed. Racing motors of this size have, however, given almost, if not quite, 100 horse-power, and even if it were possible to do so it is a question whether it is worth while to search out a formula which would embrace such divergent practice and conditions of operation. The Royal Automobile Club formula corresponds to combining a piston speed of 1000 feet per sec. with a mean pressure of 67·2 lb. per square inch. Before it can be revised a complete series of careful experiments on engines of sizes ranging from 2 inches to 10 inches should be carried out.

In the succeeding article the writer proposes to discuss details of the recent mechanical improvement of the internal-combustion engine in relation to the theoretical investigations already discussed.

H. E. WIMPERIS.

CONFERENCE OF ENGINEERS AND SHIPBUILDERS AT GLASGOW.

A JOINT summer meeting of the members of the Institution of Engineers and Shipbuilders in Scotland and of the North-east Coast Institution of Engineers and Shipbuilders was held in Glasgow on August 4, 5, and 6. It is of interest to note that, although a large number of works and shipbuilding yards was thrown open to visitors, no works in which Admiralty work is under construction were included. This arises from the firms concerned paying respect to the wishes of the Admiralty that as much secrecy as possible should be observed regarding the details and progress of Government work. Wednesday and Thursday mornings were reserved for the reading and discussion of papers, of which we give brief extracts.

Sir Andrew Noble contributed some notes on the history of propellants. Perhaps the easiest way of showing the striking difference between the old gunpowders and some of the modern propellants is to quote two tables given by the author. As both the units of heat and the quantity of gas vary considerably, depending on the pressure under which the propellant is exploded, the author has taken the transformation approximately at the pressures at which the propellants are generally used in guns.

Older Propellants.

	Pebble	R.L.G.	F.G.	Mining powder	Spanish* powder
Volumes of gas	278	274	263	360	234
Units of heat	721	726	738	517	767
Comparative energy	200,438	198,924	194 094	186,120	179,478

Modern Propellants.

	Cordite, Mark I.	Italian ballistite	M.D. cordite	Norwegian 167	Nitro-cellulose	Norwegian 165
Volumes of gas ...	875·5	810·5	913·5	899·9	934·0	909·9
Units of heat ...	1246·0	1305·0	1030·0	1005·5	924·0	935·5
Comparative energy	1,090,873	1,057,703	940,905	904,850	863,016	851,212

It will be seen from the tables that the comparative energies of the modern explosives are more than four times as great as those of the older propellants.

As regards the serious question of erosion, in the case of very large guns it is important to remember that, while the surface of the bore subject to the more violent erosion increases approximately as the calibre or a little more, the charge of the propellant required to give to similar projectiles the same maximum velocity increases as the cube of the calibre. Consequently, unless special arrangements as to the projectile are made, or other means adopted, the life of the largest guns before re-lining must be short when compared with that of smaller guns. Attention should be given to the best method of reducing erosion when very large charges are used, either by lowering the temperature of explosion or possibly by introducing some cooling agent with the charge.

The author has tested the capacity for erosion of several explosives, and has found these to vary considerably, but all give similar results with varied charges. Thus the erosion due to one three-quarter charge was less than that of a full charge, but two three-quarter charges gave more erosion than one full charge. Two half charges gave less, but three half charges gave more, erosion than one full charge. These experiments controvert the statement which has been made frequently that the erosion due to four three-quarter charges, as also that due to sixteen half charges, are equivalent to the erosion due to one full charge.

A paper on the trials and performances of the S.S. *Otaki*, by Engineer-Commander W. McK. Wisnom, R.N., is of interest in view of this vessel being the first merchant vessel fitted with a combination of reciprocating and turbine machinery. The *Otaki* was built by Messrs. Denny, of Dumbarton, and delivered in November, 1908. She has since completed a voyage to New Zealand and back, and is virtually a sister ship to the twin-screw vessels *Orari* and *Opawa*, fitted with reciprocating engines and constructed by the same builders. All three vessels belong to the New Zealand Shipping Company.

The only important differences in the vessels consist in an increase in length of the *Otaki* of 4 feet 6 inches to make up for the loss in cargo capacity due to three shaft tunnels instead of two, and also the modified design of the stern and stern post in the same ship. The boiler installations in the three vessels are identical. The engines of the *Otaki* consist of two sets of ordinary triple-expansion reciprocating engines driving wing propellers, and a low-pressure turbine driving a central propeller. In ordinary ahead working the reciprocating engines exhaust into the turbine, and change valves are fitted so that the reciprocating engines can also exhaust direct to the condensers.

At the trials on the measured mile at Skelmorlie the *Orari* attained a mean speed of 14·6 knots; the *Otaki*, under the same conditions, attained a mean speed of more than 15 knots for a total water consumption per hour of 6 per cent. less than that of the *Orari*. The total water consumption per hour in the *Otaki* at 14·6 knots was 17 per cent. less than in the *Orari* at the same speed.

On the run from the Clyde to Liverpool, with the vessel partly loaded, on November 21 and 22, 1908, at about half power, the coal consumption was about 1·387 lb. per horse-power per hour for all purposes. Scotch coal was used, having a heating value of about 7500 centigrade units.

As regards the performance of the *Otaki* on service, the coal consumption on the voyage from Liverpool to Teneriffe was 11 per cent. less than the mean for the sister vessels *Orari* and *Opawa* under similar conditions and at practically the same speed. For the round voyage, at the same speed, the coal consumption of the *Otaki* is about 8 per cent. less than that of her sister ships. The engines of the *Otaki* made a non-stop run from Teneriffe to New Zealand, a distance of 11,669 miles as logged, which is probably the longest continuous run yet made by a marine turbine. The turbine worked perfectly satisfactorily throughout the whole round voyage.

The New Zealand Shipping Company is to be congratulated in allowing this experiment to be made, and also for its courtesy in rendering available the very full information contained in the paper regarding the performances of their vessels.

PAPERS ON REPTILES AND FISHES.

A NEW species of leathery, or leather-back, turtle from the Miocene of Maryland is described by Mr. W. Palmer in No. 1669 of the Proceedings of the U.S. National Museum under the name of *Psephophorus calvertensis*, this being the first representative of the genus, which was previously known from the Tertiaries of Europe and Egypt, hitherto recorded from American deposits. It is, however, pointed out that certain dermal armour from the Zeuglodont Limestone of North America, figured by Müller in his work on Zeuglodon, probably belongs to the same genus.

In No. 1681 of the same publication Dr. L. Stejneger gives the name *Mesopeltis longifrenis* to a snake from

Panama, which appears to have been previously undescribed.

The first part of the second volume of the Memoirs of the Indian Museum is devoted to the initial portion of a report, by Dr. N. Annandale, on the fishes taken by the Bengal fisheries steamer *Golden Crown*; this section, which is illustrated with five plates, dealing with the skates, rays, and sawfishes. In the group of sting-rays and butterfly-rays, new species of the genera Trygon and Urogymnus are described and named, while in the torpedo-rays, in addition to a new species of Narcine, Dr. Annandale proposes the unclassical term "Bengalichthys" for a ray distinguished from Astrape by its thickened and fleshy disc, rudimentary pectoral fins, and degenerate eyes.

A second new genus of rays, Dactylobatus, has recently been proposed by Messrs. B. A. Bean and A. C. Weed in No. 1682 of the Proceedings of the U.S. National Museum for a species of which two examples were taken off South Carolina nearly a quarter of a century ago. The generic name refers to the presence of a finger-like process jutting from the middle of each pectoral fin, which, together with the subcircular form of the disc, distinguishes this handsomely spotted species from the typical rays of the genus Raia.

In No. 1677 of the publication last quoted Messrs. D. S. Jordan and J. O. Snyder describe, under the name of *Coregonus oregonius*, a new "white-fish" from the McKenzie River, Oregon, where it is locally known as the "chisel-mouth Jack." It is an active, predaceous fish about 18 inches in length, which takes the fly readily.

To the June number of the *Zoologist* Mr. R. Elmhirst, superintendent of the Marine Biological Station at Millport, communicates a note on whelks as cod-food. Cod, it is well known, feed chiefly on crustaceans, but two cases are on record where large numbers of whelks were taken from the stomachs of these fishes. Now, although these molluscs, generally with the operculums cut off, are frequently used as bait in cod-fishing, the number of whelks with their operculums in the two instances mentioned indicates that these had not been taken on lines, but devoured in the course of natural feeding. The author is of opinion that cod seize whelks when the foot is protruded, and swallow this part alone, rejecting the shell and its contents by means of a vigorous shake.

In the same issue Mr. L. E. Adams gives some additional notes on the flying-fish problem, in the course of which it is suggested that the discrepancy between the accounts of different observers with regard to the occurrence of wing-vibration may be due to the "personal equation" in the matter of vision-power.

PRIMITIVE DIPROTODONTS.

AT last, it seems, the true position of Plagiaulax, of the Dorsetshire Purbeck, described by Hugh Falconer in 1857, has been more or less definitely determined, and this by means of its early Tertiary American relative Ptilodus, of which remains, in a much more satisfactory condition than any hitherto known, have recently been discovered in Montana. These are described by Mr. J. W. Gidley in No. 1689 (vol. xxxvi., pp. 611–26) of the U.S. National Museum Proceedings under the name of *P. gracilis*. Of late years Plagiaulax and Ptilodus, together with a number of more or less nearly allied types, collectively forming the Multituberculata or Allotheria, have been tentatively associated with the Metatheria on account of a presumed resemblance of their cheek-teeth to those of the platypus. A study of the skull, pelvis, and limb-bones of the American genus has, however, convinced Mr. G'd'ey that this is wrong, and that the Plagiaulacidæ (together with the other Multituberculata) are really marsupials. The unequal development of the fore and hind limbs, the characters of the incisors, the form of the palate, and the position of the cheek-teeth indicate, in his opinion, a close, although not ancestral, relationship with the diprotodont marsupials.

This is practically a confirmation of the original view of Falconer, who regarded Plagiaulax as related to Hypsiprymnodon (Potorus). Cope (who was followed by Mr. Lydekker on p. 195 of the fifth volume of the "Catalogue of Fossil Mammalia in the British Museum") endorsed, in a somewhat modified manner, this opinion, regarding the Multituberculata as primitive diprotodonts presenting some very specialised features. In the course of his investigation Mr. Gidley has been led to conclude that Bolodon of the English Purbeck is inseparable from Plagiaulax, while the American Chirox is identical with Ptilodus.

The dental formula of Ptilodus is $i.\frac{1}{1}$, $c.\frac{1}{1}$, $p.\frac{2}{2}$, $m.\frac{5}{5}$ The lower jaw is attached obliquely to the skull in such a manner that its condyle is raised above the line of the cheek-teeth (thereby doing away with an objection raised by Owen against the herbivorous nature of Plagiaulax), and the greater portion of the large cutting lower premolar does not, in consequence, bite against the upper cheek-teeth, which extend considerably in advance of the same. Mr. Gidley's views, especially if the Triassic Microlestes (a name which it has recently been proposed to replace by Thomasia) belong to the same group as Plagiaulax, will considerably modify opinion with regard to the origin and radiation of the diprotodonts.

PROBLEMS OF AVIATION.

THE interim report of the Advisory Committee for Aëronautics, which, in his recent speech in the House of Commons, Mr. Haldane promised shortly, has now been published (Cd. 4711). It will be remembered that the duty of the committee is to advise on questions submitted to it by the Government departments to which the work of constructing and experimenting with aëroplanes and dirigibles has been entrusted. This work necessitates, in some cases, experimental research at the National Physical Laboratory. The committee is intended generally to advance the applications of the science of aëronautics by such means as may seem best. It has arranged already for a series of reports as to the present state of knowledge on the questions which will have to be considered. These reports are to include papers on the following subjects:—Mr. A. Mallock, on general questions to be studied; Dr. T. E. Stanton, on recent researches on the forces on plane surfaces in a uniform current of air; Sir G. Greenhill, on stability and on the screw propeller; Dr. W. N. Shaw, on wind structure, dealing especially with the phenomena of gusts, and on the variation of wind velocity with height; Mr. F. W. Lanchester, on petrol motors for aëronautical purposes; Dr. W. Rosenhain, on light alloys; and the secretary (Mr. F. J. Selby), on existing knowledge on the subject of the accumulation of electrostatic charges on balloons, and the precautions to be adopted to avoid the dangers arising therefrom.

To make it possible to decide what work should be undertaken first at the National Physical Laboratory, the committee drew up a list of desirable experiments as follows:—

I.—*General Questions in Aërodynamics.*

(1) Determination of the vertical and horizontal components of the force on inclined planes in a horizontal current of air, especially for small angles of inclination to the current.

(2) Determination of surface friction on plates exposed to a current of air.

(3) Centre of pressure for inclined planes.

(4) Distribution of pressure on inclined planes.

(5) Pressure components, distribution of pressure and centre of pressure for curved surfaces of various forms.

(6) Resistance to motion of bodies of different shapes; long and short cylinders, &c.

(7) Combinations of planes; effect on pressure components of various arrangements of two or more planes.

II.—*Questions Especially Relating to Aëroplanes.*

(8) Resistance components for aëroplane models.

(9) Resistance of struts and connections.

(10) Resistance of different stabilising planes, both horizontal and vertical.

(11) Problems connected with stability:—(i.) mathematical investigation of stability; (ii.) the stability of aëro curves of different section and of different plan (Turnbull's experiments); (iii.) effect of stabilising planes and investiga-

tion of questions as to their size and position; (iv.) effect of rudder action; (v.) effect of gusts of wind; (vi.) investigations as to stability of models for different dispositions of weight, &c.

(12) Materials for aëroplane construction.

(13) Consideration of different forms of aëroplane, monoplane, biplane, &c.

(14) Other forms of heavier-than-air machines, helicopters, &c.

III.—*Propeller Experiments.*

(15) Efficiency and the effect on the efficiency of variations in blade area, pitch, and slip.

(16) Positions relative to the machine.

IV.—*Motors.*

(17) Efficiency.

(18) Trustworthiness and steadiness.

(19) Materials of construction.

(20) Design.

V.—*Questions Especially Relating to Airships.*

(21) Materials of construction, strength, &c.:—(i.) alloys, wood, bamboo, &c.; (ii.) balloon fabrics; (iii.) wires, cords.

(22) Production of hydrogen.

(23) Gas-tightness of fabrics.

(24) Detection of leakage.

(25) Air resistance to ships of different form; experiments on models:—(i.) effect of shape of ends; (ii.) effect of length; (iii.) variation with speed; (iv.) distribution of pressure as affecting stability, strength in construction, position of propellers, fins, &c.; (v.) total resistance of models rigged to represent different balloons.

(26) Questions as to stability of airships in different positions.

(27) Stabilising and steering appliances, fins, rudders, &c.; form and position.

(28) General design.

(29) Navigation of airships. Mooring, &c.

(30) Efficiency and position of propellers for airships.

(31) Motors for airship work.

VI.—*Meteorology.*

(32) General information relating to variations of wind velocity and phenomena connected with gusts of wind.

(33) Relative variation in speed and direction of the wind at different heights above the earth's surface.

(34) Vertical movements in the air.

(35) Rotary movements in the air.

(36) Electrical phenomena.

(37) Formation of clouds, snow, hail, &c.

Eventually the committee decided that the following researches should be undertaken at once:—

(*a*) Experiments on air resistance and on air friction as outlined in (1) to (7) above, and including experiments on models of airships and aëroplanes, resistances of wires and connecting stays, &c.

(*b*) Motor tests.

(*c*) Propeller experiments.

(*d*) Tests for gas-tightness of materials suitable for dirigibles.

(*e*) Experiments on the behaviour of different materials with reference to the accumulation of electrostatic charge, and generally as to means of protecting airships from the effect of electrical discharges.

The interim report points out that additions to the existing buildings at the National Physical Laboratory have been found necessary to provide space for part of the experimental work, while a special building is also being provided for the whirling table referred to below. The equipment which is now being installed comprises the following:—

(i.) A wind channel 4 feet square and about 20 feet long, with a fan giving a draught of 40 feet per second, special arrangements being made to obtain a uniform flow. This will be employed for the determination of the air-pressure components on plane and curved surfaces, for the resistance of models of airships and aëroplanes, and for observations on the centre of pressure, frictional resistance, stability, &c.

(ii.) A whirling table of about 70 feet diameter. For this a special building is being erected; the table itself is under construction in the laboratory. It will be employed for a repetition of Dines's and Langley's experiments, as well as for propeller tests, which are urgently called for.

(iii.) Two wind towers for experiments in the open. These will enable some of the air-channel experiments to be repeated on a larger scale in the natural wind, and will, it is hoped, afford valuable information as to the varying conditions which obtain in practice.

(iv.) Apparatus for efficiency tests on high-speed motors up to 50 horse-power.

In addition, certain machine tools, &c., are being provided for workshop use.

The evidences provided by the interim report of the activity of the committee are gratifying in view of the activity being displayed in other countries in practical aviation. We notice that, on August 7, M. Sommer added another triumph to France in this province of aëronautics. M. Sommer beat the world's record for length of time in the air by flying at Châlons for 2h. 27m. 15s. The record was previously that of Mr. Wilbur Wright, who, on December 31 last, remained in the air at Le Mans for 2h. 20m. 23s.

THE MAGNETIC OBSERVATORIES OF THE U.S. COAST AND GEODETIC SURVEY.[1]

A LIBERAL addition made in 1899 to the funds available for magnetic work by the U.S. Coast and Geodetic Survey enabled a great extension to be made in the direction of magnetic observatories. Previously to that date the only magnetographs run by the Survey were an old Brooke instrument, first set up in 1860 at Key West, and an Adie instrument installed in 1882 at Los Angeles, and subsequently in use elsewhere. These two instruments are still in use, the Brooke in modified form at Vieques, the Adie at Cheltenham (fourteen miles south-east of Washington, D.C.), the central station of the Survey. Cheltenham also possesses a new set of Eschenhagen instruments, and similar instruments were also obtained for Baldwin, Sitka, and Honolulu. The curves from the five observatories are tabulated at a central office, and the volumes containing the earliest years' results have recently appeared. The material is dealt with after a uniform plan. Each volume discusses the buildings and instruments, and enumerates the base-line and scale-value changes. It is interesting to learn that the experience at Cheltenham "is decidedly favourable to the old Adie type, on account of its greater stability and the less frequent adjustments required." Another instrumental point of interest relates to the temperature coefficients of the horizontal force instruments. That of the Adie instrument appears exceptionally large for an instrument of its type, but it is less than half the average value for the four Eschenhagen instruments, and only one of the latter is worse than the Brooke in this respect. When a rise of 1° C. in temperature produces the same effect in the trace as a fall of 17 γ in the force—as seems to be the case at Honolulu—satisfactory elimination of temperature effects must be troublesome. If the cause lies in the quartz-fibre suspension, a substitute should be sought for.

The greater part of each volume is devoted to the hourly readings from the curves. Declination and horizontal intensity results are given for all the stations, but vertical intensity results only for Cheltenham. Mean hourly values are deduced for each month, first from all the days, and, secondly, from the ten least disturbed days. The latter form the basis of the regular diurnal inequalities given for each month. Inequalities are calculated for the northerly and easterly components as well as for declination and horizontal intensity, and at Cheltenham for dip as well as for vertical intensity. Under the heading "Daily Range of Declination" we have tables of values

[1] Results of Observations made at the Coast and Geodetic Survey Magnetic Observatories, Cheltenham, Maryland, 1901-4. pp. 206; Baldwin, Kansas, 1901-4, pp. 138; Sitka, Alaska, 1902-4, pp. 129; near Honolulu, Hawaii, 1902-4, pp. 130; and Vieques, Porto Rico, 1903-4, pp. 70. By Daniel L. Hazard, Computer, Division of Terrestrial Magnetism. (Washington: Government Printing Office, 1909.)

of the maximum and minimum for each day, and their times of occurrence, to the nearest minute; but the actual *range* is not given explicitly. The space allowed to the date is unnecessarily large, and it would probably be found possible to add the daily range without unduly crowding the figures. This would be a welcome addition.

An interesting feature is a list of the disturbed days, classified 1 to 4 according to the intensity. The highest figure, 4, is reserved for one or two exceptional disturbances, being applied at one or two stations only to October 30–31, 1903. Copies are also given, except in the case of Baldwin, of the curves from a considerable number of the disturbed days, the same selection being made for all the stations. This is likely to prove a valuable feature. Its value, however, is somewhat lessened by the fact that the curves are shown on a considerably reduced scale. Comparisons requiring high accuracy in the time must suffer. The fact that local time is employed is also somewhat of an obstacle to inter-comparisons. The disturbed curves are all from Eschenhagen instruments, which record all the elements on one sheet. This brings before the eye all that was happening simultaneously in the several elements. This is a distinct advantage in the study of disturbances, provided the different curves can be kept distinct. Sitka, owing to its higher latitude, is exposed to larger magnetic storms than the other stations, and the clearness of a good many of the curves reproduced suffers from crossing and confusion of the declination and horizontal force traces. October 30–31, 1903, was naturally an outstanding case of this; but on that occasion there was, besides, great loss of trace, the movements being so rapid that no clear record appeared on the photographic paper. The sensitiveness of the horizontal force instrument at Sitka was reduced towards the end of 1904 to about 1 mm. = 3 γ, as compared to an average of about 1 mm. = 1·8 γ in 1902 and 1903. The sensitiveness that used to be aimed at in temperate Europe is 1 mm. = 5 γ, and we cannot but think that the reduction of sensitiveness in Sitka might with advantage go a good deal further than it has yet gone. Though not quite so easily effected, a reduction in the sensitiveness of the declination instrument at Sitka might also be advantageous, at least for a study of the larger features of magnetic storms. The device of two mirrors adopted in the magnetographs to avoid loss of trace is an alleviation if the movements are slow, but if, as is frequently the case, the movements are not merely large but rapid, this device may only aggravate the confusion of trace.

The volumes contain a great mass of facts, clearly printed, presented in a readily intelligible form. Having put their hand to the plough, it is to be hoped that those responsible for the work of the Coast and Geodetic Survey will not turn back until simultaneous records have been obtained for at least one sun-spot cycle at all the stations.

C. CHREE.

RECENT ADVANCES IN OUR KNOWLEDGE OF SILICON AND OF ITS RELATIONS TO ORGANISED STRUCTURES.[1]

NOT only is silicon widely diffused in nature in the many forms of its oxide, but it also constitutes between one-third and one-fourth of the original and non-sedimentary rocks—of which the solid crust of the earth largely consists—in these cases being chemically combined with oxygen and various metals, forming natural *silicates*. The subjoined table gives a necessarily very rough estimate of the relative proportions in which the chief constituents are present.

THE EARTH'S CRUST.

Approximate average Composition of non-sedimentary Rocks.

Oxygen	about 47 per cent.
Silicon	,, 28 ,,
Aluminium	,, 8 ,,
Iron	,, 7 ,,
Calcium and magnesium ...	,, 6 ,,
Alkali metals	,, 4 ,,

[1] From a discourse delivered at the Royal Institution on Friday, May 28, by Prof. J. Emerson Reynolds, F.R.S.

The crust of the earth is, in fact, a vast assemblage of silicon compounds, and the products of their disintegration under the influence of water and other agents are the various forms of clay, sand, and chalk which constitute so large a portion of the earth's surface.

The solid crust of the earth is actually known to us for but a very few miles down—thirty at most—our deepest mines being mere scratchings on its surface; but, so far as known, practically all its constituents are fully oxidised, and this is probably true at much greater depths. During æons past oxygen has been absorbed as the earth cooled down, and the product is the crust on which we live.[1] It is probable that the proportion of oxygen diminishes away from the surface until it disappears almost wholly. What of the deeper depths? Are the comparatively light elements arranged more or less in the order of density? Are we to suppose that silicon and some carbon, aluminium, calcium, the elements chiefly comprising the crust, are those nearer the surface, and iron, copper, and the heavier metals nearer the centre?

Until recently we knew little more than that the earth is some 8000 miles in diameter, that its mean density is 5·6–5·7, and that its relatively thin outer skin, or crust, has approximately the composition already described. By a very skilful use of earthquake observations Mr. R. D. Oldham has, however, lately[2] given us something like a glimpse within the ball, and concludes from his observations that about five-sixths of the earth's radius includes fairly *homogeneous* material, and that the remaining sixth at the centre consists of substances of much higher density. Assuming this to be even roughly true, we conclude that silicon forms probably as great a proportion of this large mass of the earth—whether in the free state or in the forms of silicides—as it does of the crust.

Having thus magnified the office of the important element of which I wish to speak to you, I shall pass to my next point, which is how the element can be separated from quartz or other forms of the oxide, for it is never met with unless combined with oxygen in any of the rocks known to us.

I have already mentioned that quartz is a dioxide of the element—in fact it is the only known oxide—hence if we remove this oxygen we should obtain free silicon. This is not a very difficult matter, as it is only necessary to heat a mixture of finely powdered quartz with just the right proportion of metallic magnesium. The metal combines with the oxygen of the quartz, and forms therewith an oxide of magnesium, while silicon remains. If the material be heated in a glass vessel the moment of actual reduction is marked by a bright glow, which proceeds throughout the mass. When the product is thrown into diluted acid the magnesium oxide is dissolved, and nearly pure silicon is obtained as a soft, dark-brown powder, which is not soluble in the acid. This is not crystalline, but if it be heated in an electric furnace it fuses, and on cooling forms the dark crystalline substance on the table, which, as you see, resembles pretty closely the graphitic form of carbon, though its density is rather greater (2·6, graphite being 2·3).

Silicon Analogues of Carbon Compounds.

The points of physical resemblance between silicon and carbon are of small importance compared with the much deeper-rooted resemblance in chemical habits which exists between the two elements. This is expressed in the periodic table of the elements as in the following diagram:—

Na = 23, Mg = 24, Al = 27, **Si** = 28, P = 31, S = 32, Cl = 35·5
Li = 7, Be = 9, B = 11, **C** = 12, N = 14, O = 16, F = 19

where silicon is represented as the middle term of a period of seven elements of increasing atomic weights, just as carbon is the middle term of the previous period. The fact is, these two electro-negative or non-metallic elements play leading parts in the great drama of nature, silicon

[1] An interesting calculation has been made by Mr. Gerald Stoney, from which it appears that a stratum only 9 feet in depth of the surface of the earth contains as much oxygen as the whole of our present atmosphere. (See *Phil. Mag.*, 1899, p. 566.)

[2] R. D. Oldham, "Constitution of the Interior of the Earth." (Quarterly Journal of the Geological Society, vol. lxii., 1906, pp. 456–75.)

dominating that which has to do with dead matter, while carbon is the great organ-building and maintaining element of all living things. While each carries on the work to which it is best suited under existing terrestrial conditions, they both go about it in somewhat similar ways, and each one shows a tendency to overstep the border line and perform the other's part. This tendency is for various reasons much more marked in the case of carbon, but I hope to show you presently that silicon is by no means out of touch with living things, and, further, that it exhibits capacities which render it a potential element of life under other conditions of our planet, but more especially at a much higher level of temperature.

I do not propose to dwell in much detail on the remarkable parallelism of some silicon and carbon compounds, but must refer shortly to a few of them, and the oxides naturally come first.

The lecturer then described silicon oxide, chloride, bromide, chloroform, &c., with the analogous carbon compounds, and continued:—Both silicon and carbon form gaseous compounds with hydrogen of similar composition:—

$$CH_4 \text{ and } SiH_4.$$

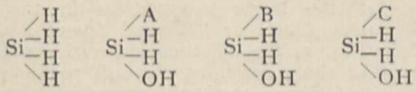
Neither of these hydrides can be obtained by direct union of the respective elements, though they are easily obtained by indirect means, with the details of which I need not trouble you. Both are colourless gases, as you see. The carbon hydride, or marsh gas, is combustible, but requires to have its temperature raised considerably before it takes fire in air, and its flame is only slightly luminous. It produces on complete oxidation water vapour and carbon dioxide gas. The analogous silicon hydride takes fire much more easily in air, and when not quite pure is even spontaneously combustible under ordinary conditions, and it burns, producing water vapour and solid silicon dioxide.

"*Silico-organic Chemistry.*"

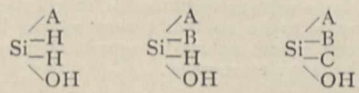
Now, just as marsh gas may be regarded as the starting point of that great branch of science which is usually spoken of as organic chemistry, so the analogous hydride of silicon is the primary compound from which many substances, which are often termed silico-organic compounds, can be derived by various means, and these were discovered in the course of the classical researches of Friedel, Crafts, Ladenburg, and others.

I wish to avoid using many chemical formulæ, which probably would convey but little meaning to some of those whom I address; it will suffice merely to indicate the *lines* on which investigations have proceeded in this direction.

In the older work of Friedel, Crafts, and Ladenburg, they produced complex substances by the substitution of various radicles (always carbon groups), for one atom of hydrogen in SiH_4, and ultimately replaced another atom of hydrogen by the OH or hydroxyl group. The substances so formed were silicon *alcohols*, which may be represented in the following manner, A, B, and C being used to indicate the different complex replacing radicles:—



In this way silicon alcohols were built up which proved to be analogous to well-known carbon alcohols, and afforded analogous acids, &c., on oxidation. These discoveries laid the foundations of a silico-organic chemistry, and have been further extended in later years. For example, it has been found possible to pursue the analogy with known carbon compounds in the direction of replacing all the hydrogen in silicon hydride by different radicles, and these changes, which can be effected in successive stages, may be represented in harmony with those just given:—



The two last of these are *asymmetric*, since all four radicles are different. Consequently, they should exist in two isomeric modifications if really analogous to known carbon compounds of the same order, and each form should be capable of acting differently on polarised light.[1] Dr. F. Stanley Kipping, who has specially investigated this kind of substitution with much success, finds that the analogy between these asymmetric silicon and carbon compounds is complete in regard to optical activity as to other general characters.

Silicon Compounds including Nitrogen.

This was all good so far as it went, but some highly important information was still wanting. As you know well, the various compounds including carbon and *nitrogen* play by far the most important parts in building up organised structures under the influence of vital energy, but in the silicon series we were almost wholly ignorant of the existence of such compounds until within recent years, when I undertook definitely to investigate this branch of the subject.

All that was known at the period of which I speak was that silicon forms a white nitride of uncertain composition when strongly heated in an atmosphere of nitrogen gas, and that when silicon chloride is brought in contact with ammonia and similar substances violent action occurs, but the nature of the products formed was not known owing to special practical difficulties in separating them.

The first step taken was to examine the action of silicon halides (*i.e.* chloride, bromide, &c.) on substances free from oxygen, but rich in nitrogen. The earliest of these worked with were thiocarbamides, but in all these cases the silicon halide merely united with the nitrogen compound as a whole, in some instances producing very curious substances, of which the one with allyl-thiocarbamide,

$$(C_3H_5.H_3N_2CS)_8SiBr_4,$$

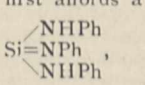
is a good example. This is a liquid which flows so slowly at ordinary temperature that it requires nearly a month in order to fall from the top of its containing tube and find its level at the bottom. Several similar substances have been obtained and examined, and their products of decomposition studied, but they do not belong to the class of which I was really in search.

It would weary you to give the details of scientific prospecting which one has to go through in order to attain definite results in a new line of work like this; suffice it to say that success attended the efforts at last, and a finely crystallised and perfectly defined compound was obtained in which silicon is wholly in direct chemical combination with nitrogen, and a specimen of that substance I now show you. Its composition is represented by the expression

$$Si(NHPh)_4,$$

where Ph stands for the phenyl group, and its name is silicophenylamide.

This substance when heated undergoes some important changes, which resemble rather closely similar changes that can be effected in analogous compounds of carbon with nitrogen. Thus it first affords a *guanidine*,



analogous to the well-known carbon guanidine, and further a di-imide, $Si(NPh)_2$, which only needs the addition of a molecule of water to convert it into a silicon *urea*, $SiO(NHPh)_2$. Many other substances have been produced similar to silicophenylamide, and they afford analogous products to these just mentioned; but these have been fully described elsewhere, and need not be dealt with here.

Silicon in Relation to Organised Structures.

The general results of these researches are that we now know a considerable number of silicon compounds including nitrogen, which resemble those of carbon with nitrogen, both in composition and in the general nature

[1] These changes are represented above as having been effected through the silicon alcohols in order to avoid complicating the general statement; other compounds have, in fact, been found more convenient for the purpose.

of the changes in which they can take part. Some of these carbon analogues are closely related to those which are concerned in building up organised structures of plants and animals.

All theories of life assume that its phenomena are inseparably associated with certain complex combinations of the elements carbon, nitrogen, hydrogen, and oxygen, with the occasional aid of sulphur and phosphorus. These are the elements of that protoplasm which is the physical basis of life, and by their interplay they form the unstable and complicated groupings of which that remarkable material is composed. All the phenomena we call vital are associated with the change of some protoplasm, and the oxidation of carbon and hydrogen; but it is quite open to question whether the connection of life with the elements first specified is inevitable. We can conceive the existence of similar groupings of other analogous elements forming other protoplasms capable of existing within much greater ranges of temperature than any plants or animals now known to us have to withstand. For example, we can imagine a high-temperature protoplasm in which silicon takes the place of carbon, sulphur of oxygen, and phosphorus of nitrogen, either wholly or in part. In fact, protoplasm, so far as we know it in purest form,

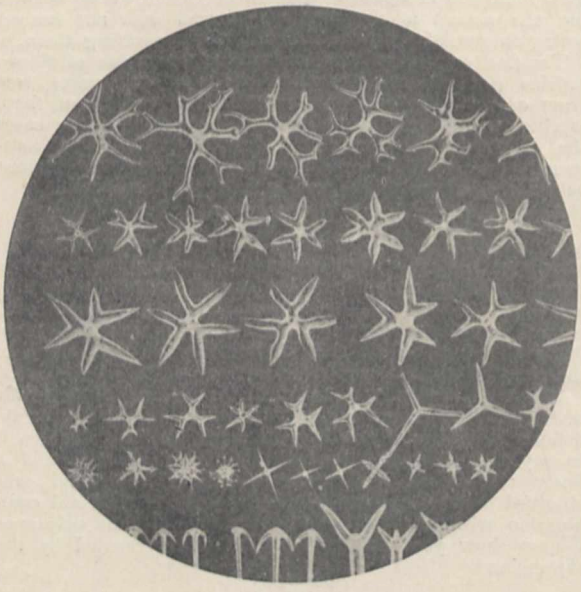


FIG. 1.

always contains some sulphur, and often a little phosphorus, representing a very partial substitution of the kind in question.

In view of our newer knowledge there is, therefore, nothing very far-fetched in supposing that under suitable conditions a plant or an animal organism may be able to construct from silicon compounds, ultimately derived from the soil, something akin to silicon protoplasm for use in its structures.

You will now ask me whether there is any evidence that anything of this kind actually occurs in nature. I think there is, although I admit that the evidence is not very varied so far as we yet know.

First, as to the *vegetable* kingdom. It is well known that many plants take up silicon in some form from the soil, and use it in ways which my botanical friends tell me they do not at present understand. Silicon is present in the straw of cereals, such as wheat, oats, &c., and in most of the Gramineæ. It was supposed that the stiffness of the straw was secured by a siliceous varnish, but this view is not now in favour, as it has been found possible to remove silica from the straw by careful treatment without diminishing its rigidity. It is also present in the leaves of some palms, for my friend, Dr. Hugo Müller, in the course of his extensive researches on the sugars present in certain palm leaves, has been much troubled by the presence in the extract from the leaves of siliceous compounds of unknown nature. Again, a well-known substance called "tabasheer," consisting largely of hydrated silica, including some organic matter, is obtained at the nodes of some bamboos. What purpose silicon serves in these plants, which seem to have special need for it, we do not know, but the subject appears to be well worth closer examination than it has yet received at the hands of plant physiologists.

I have on the table some good specimens of tabasheer, and can show some portions on the screen which have been rendered nearly transparent by soaking in benzene, and under these conditions exhibit traces of structure.

Next, as to the *animal* kingdom. The most satisfactory evidence that we can at present offer as to the organ-building capacity of silicon comes, curiously enough, from some of the simpler organisms of the animal kingdom. but the only group the short remaining time at my disposal permits me to notice is that of the *sponges*.

You know that these curious forms of undoubted animal life live in sea-water, and are usually anchored to rocks. The sea contains a very minute proportion of silica in solution, and the sponge has the power of appropriating very considerable quantities in the course of its life and as a part of its normal food supply. What does it do with this silica? It appears to use it in cell production, and from the cell evolves the beautiful and minute siliceous spicules which are so abundant throughout the structure of many of the sponges.

I have here some photographs of these spicules which I have had taken, and shall throw them on the screen. Two of the best of them have been made from microscopic specimens kindly lent to me by Prof. Dendy, who has made a special study of these spicules and of their modes of growth. One of these slides is reproduced in the engraving (Fig. 1).

FIG. 2.

These structures do not represent mere incrustations, but rather definite growths from the cell protoplasm, and are themselves in the nature of cells of characteristic forms. Prof. Dendy informs me that these spicules in certain cases become surrounded by a horny substance and seem to die, as if by cutting off the supply of energy as well as growing material.

In some of the larger sponges, as in the beautiful *Euplectella aspergillum*, or "Venus' flower basket," represented in Fig. 2, the siliceous material constitutes the greater part of the sponge, as the soft portion resembles a somewhat gelatinous coating from which the exquisite siliceous structure is developed.

To sum up, then, I have shown that silicon can easily take the place of carbon in many nitrogen compounds, as well as in others not including nitrogen. It therefore seems to me that we hazard no very violent hypothesis in supposing that the silicon which enters the sponge in its food, probably as an alkaline silicate, is in the marvellous animal laboratory made to take the place of a portion of the carbon of the protoplasm from which the spicules are ultimately developed.

The hypothesis is at any rate suggestive, and I hope enough has been said to commend it to your consideration, for there seems to be no doubt that silicon is capable of playing a larger part as an "organic element" than we hitherto had reason to suppose.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE appointments to chairs of chemistry in the Technical High School at Breslau were announced by mistake in last week's NATURE (p. 180) as referring to the Technical High School at Munich.

THE governors of the South-Western Polytechnic Institute, Chelsea, have appointed Mr. W. Campbell Houston to be head of the department of mechanical engineering in succession to Mr. W. W. F. Pullen, appointed to the inspectorate of the Board of Education. For the past six years Mr. Houston has been the assistant professor of engineering in the Heriot Watt College, previous to which he was chief assistant to Prof. Watkinson at the Glasgow and West of Scotland Technical College.

THE Board of Education has issued a memorandum directing attention to changes in certain syllabuses of examination for 1910 affecting students engaged in engineering and building trades. The changes affect the syllabuses in practical plane and solid geometry, practical mathematics, and applied mechanics, and aim at bringing the distribution of the subject-matter of instruction and of examination more fully into line with the prevailing requirements in these subjects in relation to the building and engineering trades.

ATTENTION has been directed recently in these columns to the serious efforts being made in several directions to secure the efficient education of children in elementary schools during the years of ordinary school life, and to provide for their further instruction in continuation schools after they have begun to work for their living. In our issue for July 8 (vol. lxxxi., p. 50) the question of child employment and evening continuation schools was considered, and in NATURE of August 5 (vol. lxxxi., p. 172) the recently published report of the Consultative Committee of the Board of Education on attendance, compulsory or otherwise, at continuation schools was reviewed. The most recent evidence of this desire to improve our system of elementary education is the Parliamentary paper (Cd. 4791) containing the report of the Inter-Departmental Committee on Partial Exemption from School Attendance. The committee was appointed (i.) To inquire into and report upon the extent to which existing enactments relating to partial exemption from compulsory school attendance are taken advantage of in urban and rural areas in England and Wales; the occupations in which children so exempted are employed, and the effect of such occupation upon the general education and industrial training of the children. (ii.) To consider the practical effects of legislation providing for the abolition or restriction of half-time employment upon industries and wage-earning, and upon educational organisation and expenditure. (iii.) To report whether, and to what extent, in view of these considerations, it is desirable to amend the law by raising the age at which partial exemption from attendance at public elementary schools is to be permitted, or by raising the *minimum* age for total exemption concurrently with affording facilities for partial exemption. The committee examined fifty-two witnesses, including representatives of chambers of commerce and agriculture, of associations of employers and of trades unions, officials of the Home Office, of the Board of Education, and of local authorities, members of the Consultative Committee of the Board of Education, certifying factory surgeons, teachers, farmers, and others whose opinions seemed likely to be of value. After an exhaustive inquiry the committee recommends:—(*a*) that all partial exemption be abolished from a date not earlier than January 1, 1911; (*b*) that, at the same time, total exemption under the age of thirteen be abolished; (*c*) that the attendance certificate for total exemption be abolished; (*d*) that total exemption at the age of thirteen be granted only for the purposes of beneficial or necessary employment; (*e*) that the ordinary condition for total exemption be due attendance at a continuation class, but (*f*) that, subject to the approval of the Board of Education, an authority may adopt as an alternative condition the passing of a standard not lower than Standard VI.; (*g*) that nothing in any legislation shall affect any children who, at the date on which it comes into operation, are partially or totally exempt from attendance at school under the by-laws previously in force; (*h*) that in the application of the Factory Act to England and Wales the provisions of sections 68–72 shall cease to be operative.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 26.—M. Émile Picard in the chair.—Methods for collecting and preserving the gases from fumaroles, springs, or volcanic soil: Armand **Gautier.** The methods suggested are described in detail, and diagrams are given. The gases are transferred, after drying, to a vacuous tube, the latter being sealed by fusion on the spot. The amount of steam accompanying the gas is also determined.—The law of fixed dissociation pressures: Henry **Le Chatelier.** A discussion of the effect of porosity on the application of the phase rule to dissociation phenomena.—The transcendental singularities of inverse functions of integral functions: Pierre **Boutroux.**—Uniform analytical functions with discontinuous singularities: Arnaud **Denjoy.**—Study of the thrust of the air on a surface: A. **Rateau.** The apparatus used allows of the simultaneous measurement of the vertical and horizontal components of the thrust separately. Curves are given showing the experimental results for certain plane and curved surfaces.—The ultra-violet band spectrum of phosphorus: A. **de Gramont** and C. **de Watteville.** The results are given in tabular form, showing a comparison of the flame and spark spectra.—The ratio between uranium and radium in radio-active minerals: Mlle. **Gleditsch.** The results published by the author in an earlier paper not being in accord with those of other workers on the same subject, the analytical method employed has been subjected to a critical examination, but without causing any appreciable change in the figures obtained. There does not seem to be any constant ratio between uranium and radium in different radio-active minerals. This conclusion necessitates a modification in the views held as to the mechanism of the transformation of uranium into radium.—The action of gravity on the induced activity of radium: Louis **Wertenstein.**—A method of registering the length of the path of the α rays, and on a peculiarity of this path: B. **Szilard.** A layer of the radio-active material was placed horizontally, and a glass plate carrying a layer of zinc sulphide, and backed with a sensitised plate, is fixed at an angle with this layer. The range of the α rays found in this way was always about 2 mm. less than that given by the ionisation method.—The decomposition of water by the ultra-violet rays: Miroslaw **Kernbaum.** The ultra-violet rays decompose water in a similar manner to the β rays of radium, hydrogen and hydrogen peroxide being produced.—The disengagement of the radium emanation: H. **Herchfinkel.** The hydrates of iron and uranium carry down nearly the whole of a radium salt in solution, and the precipitates, when dry, give off a large proportion of the emanation.—Ionisation by chemical methods: Léon **Bloch.** A criticism of notes recently published by Reboul and by Broglie and Brizard.—The ionisation of paraffin at different temperatures: Tcheslas **Bidlobjeski.**—The conditions of stability of the Poulsen arc: C. **Tissot.**—A new method of analysis by curves of miscibility; its application to oils used for food: E. **Louïse.** Various proportions of the oil under examination are mixed with pure acetone, and the temperature of complete miscibility noted. The percentage of oil plotted against the temperature of miscibility gives a curve characteristic for the oil.—The allotropic states of phosphorus: Pierre **Jolibois.** Ordinary red phosphorus is an unstable condition. By heating alone to 360° C., or in presence of a catalyst above 250° C., a new stable modification of phosphorus is obtained, termed by the author pyromorphic phosphorus, characterised by its density, 2·37. Red phosphorus melts at 724° C.—The hydrates of thorium chloride and bromide: Ed. **Chauvenet.**—Some double sulphates: M. **Barre.**—Some derivatives of 1 : 2 : 4-butanetriol: M. **Pariselle.** The derivatives described include oxyhydrofurfurane, bromobutylene oxide, and 1 : 4-dibromo-2-butanol.—The formation of gold deposits: L. **de Launay.**

—Biological observations of the Tonkin india-rubber tree: M. **Eberhardt** and M. **Dubard.**—A new parasitic entophyte of one of the Coleoptera: L. **Léger** and E. **Hesse.**—The genital stolon of the compound Ascidians; its evolution in the course of partial regression: Antoine **Pizon.**—Study of the toxic powers of the strophantines according to the method of administration: J. **Pédebidou.**—The paralysing influence exercised by certain acids on alcoholic fermentation: Mlle. M. **Rozenband.** The results, given in tabular form, show the concentration up to which no prejudicial effect is produced, and the concentration at which fermentation is completely stopped.—The action of the ultra-violet rays upon the acetic fermentation of wine: Victor **Henri** and Joseph **Schnitzler.** The ultra-violet rays from a quartz mercury vapour lamp completely arrested the acetic fermentation after thirty minutes' exposure, a smaller exposure causing the action to slow down.—The hydrolysis by diastase of the α- and β-methyl-*d*-glucosides: H. **Bierry.**—Researches on the electric charge of textile substances plunged into water or into electrolytic solutions: J. Larguier **des Bancels.**—The variation of some diastases during the metamorphosis in *Limnophilus flavicornis*: Xavier **Roques.**—The tectonic relations of the internal pre-Alps with the Helvetic strata of the Morcles and the Diablerets: Maurice **Lugeon.**—The neogenic continental formations in the Hautes-Plaines, Algeria: A. **Joly.**—An oscillation of the sea noted on June 15, 1909, in the port of Marseilles: Louis **Fabry.** This oscillation had an amplitude of 40 cm. to 80 cm., and appears to be connected with a sudden rise of 2 mm. in the height of the barometer.—Some earthquake shocks felt at Yunnan: Ch. **Dupont.**

August 2.—M. Bouquet de la Grye in the chair.—Is the virulence of the trypanosomes of mammals modified after passage through cold-blooded vertebrates? A. **Laveran** and A. **Pettit.** When blood rich in *T. lewisi* or *T. evansi* is injected into the peritoneal cavity of a snake (*Tropidonotus natrix*) the trypanosomes pass rapidly into the snake's blood, and live there several days, although their number rapidly diminishes. Some days after the disappearance of the organisms from the blood the latter remains infectious. No definite proof of the modification of the virulence of the trypanosome by passage through the snake has been obtained.—The figure and mass of the planet Uranus, deduced from the motions of the two interior satellites: Œsten **Bergstrand.** The calculations are based exclusively on observations made at the Lick Observatory. The flattening of Uranus is probably of the order of one-twentieth, corresponding to a period of rotation of thirteen hours. The mean density of Uranus is 0·16 that of the earth.—The elasticity of the terrestrial globe: Ch. **Lallemand.** A discussion of the measurements made at Potsdam by Dr. Hecker.—The variation of the magnetic double refraction of aromatic compounds. Surfused bodies and substances in the vitreous state: A. **Cotton** and H. **Mouton.** The variation of the magnetic double refraction of nitrobenzene and salol with temperature was found to be linear.—The magnetic properties of carbon and organic compounds: P. **Pascal.**—The latent heat of fusion and the specific heat of propionic acid: G. **Massol** and M. A. **Faucon.** Direct measurements of the latent heat of fusion gave 23·35 cal. per gram by one method and 19·07 cal. by another. Indirect methods based on the formulæ of van 't Hoff and de Forcrand gave 26·7 and 30·5 cal. respectively. The causes of this discrepancy are discussed.—Some ethylene amido-derivatives: G. **Busignies.** A description of a series of ethylene derivatives obtained by the action of the Grignard reagent upon alkyldiamidobenzophenones.—Remarks on the nuclear evolution in the Ascomycetes: A. **Guilliermond.**—The growth of Fucus: P. **Hariot.** Observations of the rate of growth.—Contribution to the study of sterilisation by the ultra-violet rays. Application to the butter industry: MM. **Dornic** and **Daire.** The water used in washing butter made from Pasteurised cream is treated with ultra-violet rays from a quartz mercury vapour lamp, and partially sterilised. A comparison of two samples of butter made from the same Pasteurised cream showed that the one washed with ordinary water was rancid after eight days, whilst the sample washed with the treated water was fresh after the lapse of a month.—The existence of carbonophosphates in milk. Their precipitation by Pasteurisation: A. **Barillé.**—The action of the pancreatic juice on glycogen, starch, and its components: Mme. Z. **Gruzewska** and M. **Bierry.**—The examination of plants for raffinose, and on its presence in two leguminous seeds, *Erythrina fusca* and *Entada scandens*: Em. **Bourquelot** and M. **Bridel.**—The slight penetration of the ultra-violet rays through liquids containing colloidal substances: J. **Courmont** and Th. **Nogier.** Owing to the opacity of solutions containing colloidal substances to the ultra-violet rays, the practical difficulties in the way of sterilising such liquids as beer or cultures of organisms are very great.—The action of ultra-violet light on the toxin of tetanus: Mlle. P. **Cernovodeanu** and M. Victor **Henri.**—The relation between phenol eliminated in the urine and epilepsy: J. T. **Florence** and P. **Clément.**—The geological history and the tectonic of the Atlas of eastern Numidia (Algeria): J. Dareste **de la Chavanne.**

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