Nature

A WEEKLY

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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REVIEWS AND OUR BOOKSHELF.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MARCH 4, 1909.

ASPECTS OF MODERN SCIENCE.

Science in Modern Life. By several authors. Edited by Prof. J. R. Ainsworth Davis. Vol. i. Pp. xvi+188. Vol. ii. Pp. viii+187. (London: Gresham Publishing Co., 1908.) Price, each volume, 6s. net.

IT is intended in this work, which will be completed in six super-royal octavo volumes, to survey the whole ground of science in its modern developments and aspects, and to present the results in language capable of being comprehended by lay readers. "Briefly," the prospectus states, "its aim is to give a connected account of present-day science, with special reference to its influence on modern life." A number of illustrations in the text, and many full-page plates—some in black-and-white, and others in colour—add to the interest and attractiveness of the work.

In the first volume, Mr. A. C. D. Crommelin deals with astronomy, and Mr. O. T. Jones with geology. In some respects the treatment of both subjects is reminiscent of text-book style. There can, indeed, be little difference between a good text-book and a work of this character: the fault of both, from the point of view of the average reader, is that of attempting too much. The student desires conciseness and comprehensiveness in his science manuals, but for the general reader these qualities should be subservient to that of lofty and stimulating thought. Unless this is borne in mind, a work upon any branch of science must become chiefly a catalogue of facts and theories no more interesting than a Hebrew genealogy.

The opening volume cannot claim a high place as an apostolic statement of the scientific spirit, or as a work distinguished by scope or style from a multitude of others. It is, however, an accurate and orderly record of the chief results of scientific inquiry in the domains of astronomy and geology; and as such it should achieve success. Mr. Crommelin devotes more attention to modern problems of astronomy than is usually the case, and has managed to compress a large amount of information in the seventy-one pages taken up by his section of the volume. Readers acquainted with the principles of physics will follow with interest the work described, but without this knowledge some parts will be unintelligible. For instance, about a dozen lines are devoted to the spectroscope and spectroheliograph; and it is obvious that unless the reader knows something more about these instruments, clear ideas as to the meaning of the results obtained by them can scarcely be anticipated. Mr. Jones begins with denudation and deposition, and passes to earth movements and igneous and metamorphic rocks, and cycle of denudation; he then indicates how the geographies of past ages can be reconstructed, and describes the changes and characteristics of the various periods. A good series of full-page maps, and a coloured geological map of the British Isles, are valuable aids to the study of the text.

The second volume contains the conclusion of Mr. Jones's treatment of geology, a contribution on chemistry by Mr. J. P. Millington, and one on physics is commenced by Mr. J. H. Shaxby. As Mr. Millington has essayed to present the most prominent points of organic, inorganic, and industrial chemistry in about 40,000 words, his task has been a difficult one, but his performance of it is very creditable. Whether the significance of some of the statements made—particularly in the treatment of organic chemistry—will be understood without a preliminary study of the subject must be left to individual experience to decide. The noteworthy characteristic of Mr. Shaxby's chapters on measurement, motion, properties of matter and heat, and, indeed, of the greater part of the work, is the attention given to modern research and thought.

In a work by several authors, equality of treatment and the ability to distinguish between the essential and unessential can rarely be secured from all contributors; and no greater success in this direction can reasonably be hoped for than that realised in the present volumes. At the same time, we may remark that the three sections so far completed differ from each other in scope and style; one suggests the text-book, another is too systematic to be of

interest, and the third is difficult to follow in parts except by readers having some acquaintance with the subject. Probably the work will be best read and appreciated by readers who have already acquired a rudimentary knowledge of scientific principles and desire to know something of the problems and positions of branches of natural knowledge beyond the boundary of their own experience.

A sectional model of the frog, showing the external and internal parts of the animal, and its development from the fertilised egg to the stage in which the tail of the tadpole has nearly disappeared and the hind- and fore-legs are present, is presented with the second volume. The model should be of assistance in suggesting instructive observations to the student or teacher of natural history.

When the work is completed it will form a very useful compendium of pure and applied science, and should find a place on the shelves of many libraries. The editor is to be congratulated upon the plan, and the publishers upon the attractive form in which they have executed it.

THE EXPERIMENTAL METHOD IN ZOOLOGICAL RESEARCH.

Experimental Zoology. Part i., Embryogeny: an Account of the Laws governing the Development of the Animal Egg as ascertained through Experiment. By Dr. Hans Przibram. Pp. viii+124; 16 plates. (Cambridge: University Press, 1908.) Price 7*s.* 6*d.* net.

THE publication of a new work on experimental zoology is a sign of the times. Until comparatively lately the experimental method was not widely adopted in the pursuit of zoological inquiry. The morphologist, as a general rule, confined his attention to the form and structure of animals and the changes through which these pass in the progress of individual development, without regard to the different ways in which form and structure arise in embryogeny and the forces which control the modes of growth.

The founding of the *Archiv für Entwickelungsmechanik* was a new departure in serial zoological literature, and served to emphasise the growing importance of that branch of study which is called developmental mechanics, while the subsequent issue in America of a new journal, *The Journal of Experimental Zoology*, in which the range of subjects discussed is somewhat more extensive, was a further advance in the recognition of the experimental method as a means of zoological research. Still more recently Prof. T. H. Morgan has published a volume on "Experimental Zoology" in which he deals not only with problems of animal morphology, but with others which are in their essential nature physiological. But physiology, as ordinarily understood, still tends to signify human physiology, and the study of function in the lower forms of life, excepting in so far as it serves directly to elucidate the vital processes of the higher animals, and more particularly man, remains as yet a much neglected department of biology.

Experimental zoology may be held to comprise all those branches of zoological inquiry, whether morphological or physiological, which are conducted by observation combined with experiment. That the fundamental problems in biology cannot be solved without recourse to the experimental method is a generalisation which zoologists have been a little slow to accept, and the complete absence in this country (and, indeed, in nearly every country) of experiment stations where animals can be kept under constant observation in a natural and healthy environment is a circumstance which contrasts strangely with the comparative wealth of equipment in other branches of observational science. It is greatly to be hoped, therefore, that the appearance of such works as Dr. Hans Przibram's, which is to treat of all departments of experimental zoology, will be the means of compelling greater attention to the pressing needs of this branch of study.

We are told in the preface that the work is to be issued in five parts, each of which is to be complete in itself. The present volume deals with fertilisation and the first development of the individual organism without regard to its origin; the phenomena of regeneration are to be discussed in part ii.; variation and heredity in part iii.; the growth of the developed organism and the relation between the cell nucleus and the cytoplasm in part iv.; while the last volume is to be devoted to general physiological problems, including that of sex. The part now under notice is an English translation by Miss Hertha Sollas of a German edition published last year.

We are informed at the end of the preface that "the author has read the proofs [of the translation] and has made such additions as were necessary to bring it up to date." Nevertheless, we cannot refrain from remarking on the absence of any reference to several not unimportant papers that have appeared in recent years, and in our opinion the first chapter is calculated to convey a wrong impression of the present state of the fertilisation problem. Thus it is recorded that Winkler succeeded in fertilising sea-urchin ova with the extracted juice of spermatozoa, but there is no mention of the subsequent work of Gies (published so long ago as 1901), which showed that Winkler's results were due to osmotic influences, and not to the action of the sperm extract. Gies's interpretation has since been accepted by Loeb, while Pichou's results (published in 1905) were confirmatory of those of Gies. There is at present no experimental evidence that spermatozoa contain specific substances which, when extracted, are capable of fertilising ova. Again, in the italicised conclusion at the end of the first chapter we read that

"the cause which determines the transition of the resting animal egg cell to a state of progressive development must be sought in an acceleration of the vital processes which, even in the resting egg, are always going on."

Loeb, however, has pointed out (1906) that if such a conclusion were correct, normal sea-urchin eggs

should segment if kept for a sufficiently long period, and, further, that it ought to be possible to induce segmentation by heat, since heat is known to accelerate chemical reactions, but neither of these results could be obtained. Loeb has suggested, therefore, that the spermatozoon, in conjugating with the ovum, may very possibly remove from the latter a negative catalyser or condition, the presence of which in the ovum somehow inhibits the process of development. Strangely enough, the present work contains no account of Loeb's conclusions in regard to this matter.

Delage's recent paper (1907) is referred to in a couple of lines, but there is no mention of the fact that his latest method of artificially fertilising sea-urchins' eggs differs radically from those employed by Loeb, and consequently there is no reference to the very important conclusions which Delage deduces from his results. Moreover, we should have expected an allusion to the fact that the symmetry of the sea-urchins which Delage succeeded in rearing was hexameral instead of pentameral, an observation which seems to us to have an important bearing on recent Mendelian research and teaching. Furthermore, the statement on another page that Delage has described half the ordinary number of chromosomes for parthenogenetic echinoderms is misleading, since this author says distinctly that in such cases the normal number becomes restored by a process of "auto-regulation."

The account given of fertilisation is followed by interesting chapters on egg-structure, mitotic cell division, gastrulation, the mechanism of the development of differentiation, and the influence of external factors. We have no space left in which to criticise these. Although we have not refrained from pointing out certain shortcomings, this does not prevent us from congratulating both author and translator on the production of what is, on the whole, a very useful summary of embryogenetic research.

FRANCIS H. A. MARSHALL.

MODERN PHARMACOGNOSY.

Handbuch der Pharmakognosie. By Prof. A. Tschirch. Parts ii. to viii. (Leipzig: Chr. Herm. Tauchnitz, 1908.) Price 2 marks per part.

THE general scheme of this important work on pharmacognosy having been described in a previous issue of NATURE (vol. lxxviii., p. 629, October 22, 1908), the manner in which the scheme is being carried out may now be examined.

The bulk of the first four parts, in all about 116 pages, is devoted to "pharmacoergasy," that is, the cultivation, collection, and preparation of drugs. Numerous instances, perhaps not very systematically arranged, of the cultivation of drugs in remote ages are cited, and accounts are given of modern attempts to acclimatise important medicinal plants. The great problem of pharmacoergasy is, according to the author, the determination, not only of the conditions of growth simply, but also of those conditions that most conduce to the formation of valuable constituents, a problem which presents a boundless field for investigation. The irrationality of a number of the processes at present in use for drying drugs is indicated, and suggestions made for their improvement.

The times at which leaves and other organs should be collected are stated in general terms, but doubt may well be expressed whether these are not in several, perhaps many, instances incorrect; at least they have not been sufficiently substantiated either by chemical or biochemical assay. To allude to definite instances, it has recently been well established by the physiological experiments of Dixon supporting the assays of Fromme that the first year's leaves of the foxglove are practically of equal value with the second year's, although Prof. Tschirch would reject them as worthless. Chemical assay has also demonstrated the practical equality of the first and second year's henbane leaves, and probably also those of the annual plant were the leaves only of the latter collected and properly dried. Even the best period for the collection of aconite and belladonna cannot yet be regarded as firmly established. Schroff may well have been the first to indicate the time at which hemlock fruits should be gathered, but the admirable researches of Farr and Wright determined the point definitely by analysis.

In this section enzymes and their influence are considered, though perhaps more emphasis might be laid on their prejudicial action, and on the means now generally advocated and adopted for obviating it. A most comprehensive list of the plants cultivated in Europe and the United States is included in this part of the work, as well as a chapter on the collection of drugs, well illustrated by a number of photographs. The preparation of drugs is discussed at some length, and consists practically of well-known processes which are commonly given under each drug, but are here collected together.

Part iv. deals with "pharmacoemporia," or the commerce in drugs, a section of pharmacognosy which has until lately been only too much neglected, though of the greatest interest. Here the various routes that commerce between the East and the West has taken from ancient to modern times are briefly, though not too lucidly, traced and explained by three maps. Excellent accounts are given of the drug sales in London, Hamburg, and Amsterdam, those in London being accompanied by several illustrations identical with those first published in the *Pharmaceutical Journal* by Mr. Heap, an acknowledgment for which has doubtless escaped the author. Photographs of the most important harbours of the world illustrate this section of the work.

The commercial varieties of drugs and the packages in which they are exported form the chief subject of part v. In part vi. the advantages and disadvantages of the various pharmacognostical systems of classification that have from time to time been proposed are fully discussed, the author being in favour of one based upon the chemical relationships of the chief constituents, though he admits that such a system is at present impracticable, as the constitution of so few of the constituents is sufficiently well known. For all teachers of pharmacognosy the

chapter on instruction in the science will probably possess the greatest interest; it certainly deserves to be most carefully studied, as it is replete with stimulating suggestions. Most welcome will also be the abundant literary references, constituting the first bibliography of pharmacognosy.

Pharmacozoology is very briefly dealt with, and stands in sharp contrast with the rest of the work. Considering the success that has attended the development in recent years of organotherapy, it is difficult to understand why such widely used parts of animals as the thyroid gland, suprarenal capsule, &c., and such products of animals as pepsin, pancreatin, wool fat, &c., have been excluded from the animal drugs enumerated by the author.

All the parts of the handbook that have appeared are most profusely illustrated, and Prof. Tschirch must be congratulated on the excellence of his work.

HENRY G. GREENISH.

SCIENCE IN THE TEXTILE INDUSTRIES.

The Structure of the Wool Fibre and its Relation to the Use of Wool for Technical Purposes. By Dr. F. H. Bowman. Pp. xx+475; with many coloured and other illustrations. (London: Macmillan and Co., Ltd., 1908.) Price 8*s.* 6*d.* net.

THIS is a companion volume to the one on "The Structure of the Cotton Fibre," which was reviewed in these columns in July, 1908, and is to be followed by a third volume dealing with the silk fibre. The subject-matter is treated in a very thorough manner, commencing with a description of the structure of the skin and the genesis of the hair or wool fibre which clearly indicates the mode of its subsequent development. The physical structure of the fibre determines its behaviour during the various mechanical processes of spinning and weaving; and this important point is well brought out in the valuable and interesting portion of the book devoted to it.

Thirty-two distinct varieties of sheep are described, of which four are inhabitants of Europe, fifteen of Asia, eleven of Africa, and two of America; but there appear to be at least thirty-one subvarieties of the common sheep (*Ovis aries*), some of which differ to a greater extent than certain sheep which are regarded as distinct varieties. It is considered probable that all varieties were originally derived from two—the long- and the short-tailed sheep—both of which in the wild state grow an outer covering of hair and a softer, finer inner covering of wool, the latter increasing and the former being gradually eliminated by domestication.

The domestic sheep was first produced in Asia, and spread thence to Europe with advancing civilisation, its introduction into Greece being probably enshrined in the legend of the golden fleece.

The scientific breeding of sheep was first systematically carried out in England, but is now practised in all the important sheep-rearing countries. In this connection it is interesting to note the effect of the frozen-meat trade on the production of wool. Before the introduction of cold-storage transit, the carcase of the sheep at the Antipodes was of much less value than it is to-day. Sheep farmers therefore confined their attention to breeding for wool, but now have to pay more regard to the production of good mutton, the fleece being relatively less important.

In dealing with the question of sheep-dips, which are necessary on account of the parasites which infect all animals with a hairy or woolly covering, the author very properly condemns all compositions containing tar, or lime and sulphur, and advocates arsenical dips. The important question of the preparation of wool for the market receives, as it deserves, full attention, and the recommendations of the Wool Trade Committee of the Bradford Chamber of Commerce are given in full. Briefly, the trouble is caused by the presence of vegetable matter in wool, which may arise from want of care in packing or lack of cleanliness in the shearing house. The importance of this matter arises from the fact that the vegetable matter may accompany wool fibre throughout the whole of the manufacturing operations, and, on account of its very differing dyeing properties, may greatly detract from the appearance of the finished material even when present in very small amount.

The investigation of the mechanical structure of the wool fibre is traced back by the author to 1664, in which year a Dr. Hook read a paper before the Royal Society on the structure of various hairs, but, of course, the power of his microscope was very limited. About 1690 Leeuwenhoek published several illustrations of the microscopical structure of wool, and in 1742 H. Baker also read a paper on the subject before the Royal Society; but a Mr. Youatt, in 1835, using a compound microscope with a magnification of 300 diameters, claimed to have been the first to discover the true nature of the surface of the wool fibre.

The author of the present volume was, however, the first to make a systematic and comparative study of the microscopic structure of wools of various origin and at various stages of growth, and his illustrations, which are reproduced in the book, have for many years been considered as standards, and have been reproduced in most text-books dealing with wool manufacture or dyeing.

The description of the chemical nature and properties of wool is not so exhaustive or quite as satisfactory as that portion of the book dealing with the mechanical structure, but the chapter on the strength and testing of worsted yarns is excellent, and emphasises the importance of spinners and manufacturers making full use of such scientific aids as are now available.

The chapter on the theory of dyeing and colour is the least satisfactory in the book, and the excellent coloured diagrams represent the only feature which warrants inclusion.

The book is one of considerable importance, and will doubtless take the position of a standard work in the libraries of all connected with the textile industries.

WALTER M. GARDNER.

TREATMENT AND DISPOSAL OF SEWAGE.

(1) *Principles of Sewage Treatment.* By Prof. Dunbar. Translated by Dr. H. T. Calvert. Pp. xxiii+271. (London: Charles Griffin and Co., Ltd.) Price 15*s.* net.

(2) *Sewer Construction.* By Prof. Henry N. Ogden. Pp. xii+335. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 12*s.* 6*d.* net.

(3) *Modern Methods of Sewage Disposal.* By W. H. Trentham and J. Saunders. (London: Sanitary Publishing Co., Ltd., 1909.) Pp. viii+60. Price 2*s.* 6*d.* net.

(1) THE development of the investigation into sewage purification has proceeded on different lines in England and Germany, owing largely to the fact that practical necessities have compelled English towns to attempt some measure of purification in the absence of complete scientific information, whereas it has been possible in Germany to devote, in the first place, more attention to the theoretical aspect of the problem.

The author of this book is one of the foremost among German investigators, and consequently it cannot fail to be received with interest by those engaged in the problem of sewage purification in England; it fills a place in the literature of the subject, the requirements of which no existing work completely satisfies.

Presumably the favourable situation of many Continental towns in regard to the discharge of sewage into rivers of relatively large volume is responsible for the fact that the theory of sedimentation and technique of screening has received more attention in Germany than in England, as in certain cases thorough screening or efficient sedimentation of the sewage is all the prevailing conditions require. Where further biological treatment is necessary, it is doubtful, however, whether any elaborate screening device can be considered economical.

On pp. 47 to 59 a series of interesting and ingenious methods for screening sewage is described, and, later, valuable experiments of several German investigators are quoted with regard to the effect of varying rates of flow on the deposition of the suspended solids.

The author's conclusions in regard to the design of sewage sedimentation tanks, viz. that shallow tanks of simple construction are, as a rule, preferable to tanks of great depth, will doubtless meet with general approval.

When dealing with septic tanks the author's conclusion is that preliminary anaërobic treatment, so far from being beneficial, is actually detrimental to subsequent filtration, and he supports this conclusion by the statement that organic matter can be nitrified without the preliminary production of ammonia.

In view of the fundamental importance of this latter point, and that the author's results are not in accordance with those of Adeney, Boulanger and Massol, and other workers, it is disappointing that particular experiments are not given or specific references quoted.

It may be here mentioned that the value of the extensive bibliography given at the commencement of the book is very considerably diminished by reason of the fact that no reference is made to the text of the book, and in the majority of the cases the subject-title is omitted; this is true for all references to the author's own publications.

The absorption theory of sewage purification, which is now generally accepted as affording the most rational explanation of one of the important phases in the biological purification of sewage, is very thoroughly dealt with on pp. 140 to 149, although the experiment given previously in regard to the time of passage of sewage through a filter cannot, on account of insufficient data, be considered conclusive. W. Clifford[1] has shown in a thorough manner that this question is dependent on the following factors:—(1) Rate of application of sewage; (2) depth of filter; and (3) interstitial water, which is determined by the size and character of filtering material. As an example of what may occur in a fine-grade filter he found, when liquid was applied at the rate of 200 gallons per sq. yard to a filter 3 feet deep, composed of clean clinker $\frac{1}{8}$ inch to $\frac{3}{8}$ inch size, the average time of percolation was rather more than three hours.

The chapter on contact beds is, in the opinion of the reviewer, one of the most valuable sections of the book, as it contains a series of interesting and complete experiments, the results of which help in the elucidation of the purification changes effected.

In view of the fact that the author appears to be in favour of complete aërobic treatment, it is somewhat surprising to find that Dibdin's slate filters are dismissed as irrational, although their object is to retain the suspended solids in such a manner that aërobic decomposition may be effective.

In general, the author favours the adoption of percolating filters, but in stating their disadvantages he omits the question of production of flies and increased fungoid growth, attendant on certain types of these filters. The use of a carefully graded layer of fine material on the surface of a filter, as a means of distribution, as recommended by the author, is supported by a considerable body of experience, both in this country and on the Continent.

Dr. Calvert is to be congratulated upon an admirable translation.

(2) A course of lectures given by the author in the College of Civil Engineering, Cornell University, forms the basis of this book, which is published as a continuation of a previous work of the author's on "Sewer Design."

Outstanding features of the book are the large number of well-produced diagrams and drawings, illustrative of a great variety of constructional work carried out in various towns in America, and the numerous references, which the engineering student will find very useful.

In view of the present tendency in America to use reinforced concrete for the construction of large sewers, the various examples of this class of work described in chapter vi. will be of interest to the English engineer.

[1] Proc. Inst. C.E., vol. clxxii., part ii.

Although the book is written from the point of view of American practice, and consequently certain sections, such as the chapter on estimates and costs, will not be found so useful to English workers, the general information on constructional work, which is mainly descriptive, should be found helpful by students and those engaged in English practice.

(3) The authors have performed the unenviable task of condensing the whole problem of sewerage and sewage disposal within fifty-six small pages, in such a manner as to give the lay mind a good and, on the whole, fairly accurate elementary idea of the subject. It necessarily follows that the information afforded will not be found so useful to those actually engaged in sewage work.

In view of the adverse opinion expressed in Dunbar's "Principles of Sewage Treatment," it is interesting to note that the authors strongly advocate the preliminary treatment of sewage in aërobic slate filters.

EDWARD ARDERN.

OUR BOOK SHELF.

Explication méchanique des Propriétés de la Matière, Cohésion, Affinité, Gravitation, &c. By A. Despaux. Pp. 352. (Paris: Félix Alcan, 1908.) Price 6 francs.

THIS is an attempt to explain everything in terms of a mechanical hypothesis. The universality of application of his hypothesis is scarcely conveyed by the author in the title he has given to his book. Not only cohesion, affinity, gravitation, but also biological and psychological problems are brought within its range. What differences of opinion, therefore, may we not expect from those who read its pages! Such far-reaching generalisations must be backed up by exceptionally strong evidence before their acceptance can be reasonably entertained.

The author seems to anticipate that it will not be easy to secure adhesion to his views. He has little respect for what we may call the grand reserve of science. Official science, he says, is essentially conservative. When a discovery is made, it is said at first that it is not true; and then that it is not new. To some extent he is able to justify his belief in the "resistance" of science. Said Lavoisier, "I do not expect that my ideas will be adopted all at once." While he explained combustion by a simple combination, the partisans of phlogiston burned his effigy in Berlin. Avogadro received no attention from the French Academy, to which he presented his memoir, and it was only twenty years afterwards that he obtained recognition. Sadi Carnot's memoir remained unknown until, after twenty-four years, Lord Kelvin rescued it from oblivion.

Our author, therefore, does not expect impartiality from his contemporaries; it scarcely seems worth while to state our opinion upon his views. We will be content with indicating that he attempts to show that everything can be explained by supposing the molecule to consist of a sort of corkscrew which, spinning, sets up whirls and streams in the æther which he likens to those produced by a ventilating fan. If the molecule is "free," then by its own rotation it propels itself in space "like a fish in water or a bird in the air." It is then part of a gas. When it is part of a solid it is fixed in position, but by its rotation propels æther in front and sucks it in behind. This flow of æther through the molecule constitutes the electric charge; and so on; but for the remainder of this explanation of the universe we must refer the unbiassed reader to the volume itself.

Leçons de Physique générale. By J. Chappuis and A. Berget. Tome I. Second edition; completely revised. Pp. xii+669; illustrations. (Paris: Gauthier-Villars, 1907.) Price 10 francs.

IN a publishers' note it is claimed that the intention of this work is to fill up the gap between elementary treatises and those in which the exposition of physics is carried to its highest developments. With regard to any such works, of which numerous examples might be cited outside France, we may say there must necessarily be considerable resemblance one with another. It is in the higher developments that originality can come chiefly into evidence; so that it is not in any derogatory spirit that we assert that there is much in this book which can be obtained elsewhere, and which in such other places is as well presented as we find it here. But it would give quite an erroneous notion as to the contents of the volume if we were to be content with such an appraisement as this. For in many parts the treatment is so lucid, considering the difficulty of the matter, that we doubt whether it is possible to find a *better* book than this of the standard which it aims at attaining. It is specially rich in illustrations of classical apparatus employed in determinations for physical data.

The chapters dealing with thermodynamics are also exceedingly clear, and will be greatly appreciated by those who have mastered the mathematics necessary—which, it must be pointed out, is never very severe. The logic is beyond criticism, and the physical conceptions are accurate. We will only add that the present volume deals with measuring instruments, weight, elasticity, statics of liquids and gases, and heat. The second edition of the volume on electricity and magnetism has already appeared.

Biochemie. Ein Lehrbuch für Mediziner, Zoologen und Botaniker. By Dr. F. Röhmann. Pp. xvi+768. (Berlin: Julius Springer, 1908.) Price 20 marks.

PROF. RÖHMANN is a well-known physiological chemist, and has produced a work on that subject which will prove useful to teachers and students of that branch of science. The book is written from the standpoint of chemistry, and really is a text-book of organic chemistry which deals particularly with the substances found in animal and vegetable organisms. The biological and metabolic aspects of the subject are treated incidentally and, as a rule, with brevity. There is, for instance, no chapter that deals with the blood as a whole, but the pigment is dealt with in one place, the proteins in another, and so forth. The same is true for milk, urine, and the other secretions; there is no general survey of ferment action, of coagulation, of oxidation, and of other processes important from the point of view of the physiologist.

There are, however, many handbooks of biochemistry available to-day which deal adequately with its biological side. Prof. Röhmann's book is therefore useful as supplementary to these from the purely chemical side. To those engaged in research his book will be a great help; it contains a mine of bibliographical references, and chemical methods of analysis are described in detail. The pages bristle with chemical formulæ which make the book somewhat formidable to medical readers, to whom the book

is partly addressed, and render it unsuitable for continuous reading except to those already well versed in organic chemistry. But to those who desire to find the latest authoritative information of a chemical kind it will prove an excellent work of reference.

W. D. H.

Geometry, Theoretical and Practical. Part iii. By W. P. Workman and A. G. Cracknell. Pp. ix+66. (London: W. B. Clive, 1908.) Price 1*s.* 6*d.*

THIS part of Messrs. Workman and Cracknell's textbook deals with the subject-matter of Euclid, book xi., on modern lines, and contains also an elementary account of the parallelepiped, sphere, and tetrahedron. The characteristics of previous parts are well maintained; the brevity of treatment and the conciseness of arrangement will appeal specially to examination candidates.

LETTERS TO THE EDITOR.

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

The γ Rays of Uranium.

OUR knowledge of the γ rays of uranium has until now been confined to their discovery by Rutherford (*Phys. Zeit.*, 1902, 517) and to the observations of Eve (*ibid.*, 1907, 185). The latter directed attention to their extraordinary feebleness and to their relatively low penetrating power. Eve found that uranium gives out only about one-tenth as much γ radiation as thorium when examined through 0·64 cm. lead, which is most remarkable, considering that it gives about six times more β radiation. Whereas the γ rays of thorium have the same value for the absorption coefficient as those of radium [$\lambda(\text{cm.})^{-1}$= from 0·57 to 0·46 over a range of from 0·64 cm. to 3·0 cm. of lead], the uranium γ rays are far more easily absorbed. Eve gave the value 1·4 for λ for thicknesses of lead between 0·28 cm. and 0·92 cm. He stated that the radiation was homogeneous, that the absorption was exponential over this range, and that the rays were practically completely absorbed in 1 cm. of lead. He worked with uranyl nitrate.

Having at our disposal 50 kilograms of pure uranyl nitrate, provided by the generosity of a friend in connection with the work of one of us on the parent of radium (NATURE, January 28, 366), we have been able greatly to extend and in part to correct the work on the uranium γ rays. By a long sequence of chemical operations, known and new, but based largely on the magnificent chemical work of Sir William Crookes, who discovered the substance (Proc. Roy. Soc., 1900, lxvi., 409), we separated by far the greater part of the uranium X from the uranium, and obtained it, in the last separation, in the form of films weighing only a few milligrams. The operations absorb about twelve days. Uranium X contributes, as first shown by one of us (Trans. Chem. Soc., 1902, 860), none of the α rays, but all the β rays of the uranium, and, as is to be expected, and as the present work shows, the γ rays also. These have been found to decay at the same rate as the β radiation, namely, to one-half every twenty-two days. The initial β radiation of the bare preparation lit up an X-ray screen to about the same extent as 7 mg. of pure radium bromide contained in a sealed thin glass tube. The luminosity could be plainly seen in a fully lighted room when the screen was held in the shadow of the observer; but as Eve found, the γ radiation is extraordinarily feeble. It was accurately compared with that from a known quantity of pure radium bromide after passage through 2·5 cm. of lead by means of an electroscope. Under these conditions the uranium X was equivalent to 0·053 mg. of radium bromide. As shown later, it can be calculated that the lead screen cut down the γ rays of the uranium X to 20·6 per cent., and of the radium to 55 per cent., of their initial values. From these data, allowing for the decay during the processes of separation, it may be provisionally estimated that the radiation of the two elements, uranium and radium, is about as one to five hundred million when, as in the present case, absorption is eliminated and only the hard γ rays dealt with.

Before the activity of the preparation decayed too far we were able to determine accurately the absorption coefficient of the γ rays in fourteen substances. As Wigger found for the γ rays of radium (*Jahrb. Radioakt.*, 1905, 430), the absorption follows a strict exponential law after a certain initial thickness of substance has been penetrated, and the absorption coefficient is very nearly proportional to the density of the substance. Thus for lead between the thicknesses of 1 cm. and 5 cm.—and for all other substances over corresponding thicknesses—the absorption is within the very small limit of experimental error absolutely exponential. The value of the absorption coefficient, $\lambda(\text{cm.})^{-1}$, for lead is 0·62. In general, for all substances the value of λ/d, where d is the density, is about 0·055, as compared with 0·021 for the radium γ rays for thicknesses greater than 2·8 cm. of lead (Wigger). Thus the uranium γ rays are about two and a half times more strongly absorbed than those of radium.

The conditions of the experiment are of fundamental importance, as they affect very much the value obtained for the absorption coefficient. In our experiments the disposition was in the main similar to that of Wigger, in that the absorbing plates were clamped up tightly to form the base of the electroscope, and the preparation was placed in a definite position beneath. For insulators the upper surface was covered with a thin leaf of aluminium. Whenever practicable, the absorbing plates were all of the same material. Only for light substances, and for one experiment with mercury, was the base of the electroscope a plate of lead as in Wigger's experiments. Its thickness was 1·2 cm.

Our value for the absorption coefficient is entirely different from that given by Eve, and, indeed, it is a little doubtful what rays Eve observed. Over the range of thickness of lead he used, from 0·28 cm. to 0·92 cm., we find that the rays are not homogeneous, and the exponential law does not hold at all. There is present in relatively great intensity a *very* much less penetrating radiation, completely absorbed by 1 cm. of lead, with a value for λ from eight to ten times greater than for the penetrating type. The absorption and magnetic deviability of these rays are under examination. They would have been far less prominent relatively in Eve's measurements with uranyl nitrate than in ours with uranium X, owing to the strong absorption in the former case. It may be mentioned that the existence is to be anticipated of a very soft γ radiation corresponding to the extremely soft β radiation of uranium X (Schlundt and Moore, Levin, H. W. Schmidt). There appears to be no radiation corresponding with Eve's value of λ, but then his value for the γ rays of radium, 0·46, is about as different from Wigger's, 0·24, as his value for the uranium γ rays, 1·4, is from ours, 0·62.

The value found in our experiments for λ/d, 0·055, was actually obtained exactly for substances so different in density and nature as mercury, lead, aluminium, slate, and pine-wood, showing the remarkable range of the "density law" in this case. At the same time, we do not think it holds strictly, for brass (density 8·40) actually absorbed more than copper (8·80), and zinc (7·07) more than tin (7·25), in experiments which were strictly comparable and under good conditions. The actual experimental values of λ/d obtained varied within the extremes of 0·045 (one value for iron) and 0·068 (paraffin wax). Part of this variation, but not, we think, the whole, is doubtless due to experimental error. Although the exponential law holds, so far as we can see, quite strictly, the values obtained for λ appear to depend somewhat on the particular experiment in an as yet not completely explained way. We propose carrying out similar experiments with the γ rays of radium, in the hope of obtaining further light on the nature of the variation.

Beyond 5 cm. of lead, and corresponding thicknesses of other metals, λ appears to change and to become very

much smaller, indicating the existence of a still more penetrating type of radiation than the γ, but our preparations are hardly sufficiently active to enable us to establish this beyond doubt. Here again the experiments we propose with the radium γ rays may throw more light on the matter.

FREDERICK SODDY.
ALEXANDER S. RUSSELL.

Physical Chemistry Laboratory, University of Glasgow, February 27.

The Radio-active Deposits from Actinium.

IN NATURE of February 25 there appeared a letter from Prof. McLennan containing the results of some experiments recently made by Mr. W. T. Kennedy on the behaviour of the active deposit from actinium emanation.

So far as may be judged from the details given of the observations, they substantially confirm the results obtained by the writer, which are to be found in the *Phil. Mag.*, May and June, 1908.

The suggestion that the differences in the quantity of active deposit observed on the positive and negative electrodes can be explained by the different rates of diffusion of the ions is an interesting one, but it seems likely that the determining factor is the frequency of collision between the active deposit particles and the gas molecules or ions with which they are mixed.

It is impossible to make a complete comparison between the experiments of Mr. Kennedy and myself until further data are available. S. RUSS.

Physical Laboratories, Manchester University.

The Production of Prolonged Apnœa in Man.

NOTICING the letter by Dr. H. M. Vernon in NATURE of February 18 on "The Production of Prolonged Apnœa in Man" it recalled to my mind some observations on the same subject communicated to the *Philosophical Magazine* in 1833, vol. iii., p. 241, by Michael Faraday, and reprinted in his collected "Researches in Chemistry and Physics," pp. 358–62.

The effect of a bout of forced breathing in enabling a person greatly to prolong the time during which they can hold their breath was brought under the notice of Faraday by Sir Graves C. Haughton.

Faraday was ever one who put things to a practical use, and he gives directions as to the mode of proceeding when one had to enter a noxious atmosphere to rescue a person overcome by the fumes of a poisonous gas. He says:—"Avoid all unnecessary action; for activity exhausts the air in the lungs of its vital principle more quickly, and charges it with bad matter. Go collectedly, coolly, and quietly to the spot where help is required: do no more than is needful, leaving what can be done by those who are in a safe atmosphere (as the hauling up of a senseless body, for example) for them to do.

"Take the precautions usual in cases of danger in addition to the one now recommended [namely, by preparing the lungs by several deep breaths]. Thus, in a case of choke-damp, as in a brewer's vat, hold the head as high as may be; in a case of fire in a room, keep it as low down as possible."

He concludes his communication with a remark on the effect of increasing the pressure of the air breathed by giving the case in which Mr. Brunel, jun., descended in a diving-bell to a depth of 30 feet below the surface of the water, when it was found that both he and his companion could remain under water (by descending from the bell itself) for about twice as long as they could had the air they breathed only been under normal pressure. It would be interesting to know how long the breath could have been held in the above case had Mr. Brunel employed forced breathing, supplemented by three or four breaths of pure oxygen. If the relation of pressure and time during which the breath could be retained held good for the time of 8m. 13s. given by Mr. Vernon, this period should be increased to 16m. 26s. when air under two atmospheres (absolute) pressure was breathed, aided by about four breaths of oxygen. W. G. ROYAL-DAWSON.

40 Creffield Road, Ealing, February 23.

A Winter Retreat.

MR. GEORGE GILBERT, a market-gardener in Stonehaven, has shown me a curious phenomenon which I have not met with before, and which, I think, deserves to be recorded. About the beginning of November a number of children were playing at a tea-party, and they left among the herbaceous plants at the side of the walk an earthenware tea-pot, the dimensions of which were 4 inches by 3 inches. A few days ago the old tea-pot was discovered lying on its side and without a lid. In the interior, closely packed, were no fewer than thirty-seven of the common garden shelled-snail, and when ejected they were found to be all alive. They had spent the months in their winter retreat. Probably gardeners know that they can trap snails in some such way; at all events, one often finds snails in confined spaces and sheltered nooks. Still, the question arises, What led one mollusc to follow the others? Is it the sense of smell? What attracted no fewer than thirty-seven to this old tea-pot, probably a very snug and safe place? Still, there is a danger in being in a crowd. One can imagine how delighted a sea-gull would have been to have discovered this larder of fresh meat!

JOHN G. MCKENDRICK.

Priestley and Coulomb's Law.

IN our text-books on electricity I do not remember to have seen Priestley's name associated with the proof of Coulomb's law as derived from the fact that no electrification can be obtained in the interior of a sphere charged with electricity.

In the article "Priestley" in the "Dictionary of National Biography" it is stated that Priestley anticipated Coulomb's law, and in looking into the matter I find foundation for the statement in the following paragraph from "The History and Present State of Electricity with Original Experiments," by Joseph Priestley, second edition, 1769, p. 711:—

"May we not infer from this experiment" (absence of electrification within an electrified cup) "that the attraction of electricity is subject to the same laws with that of gravitation and is therefore according to the squares of the distances; since it is easily demonstrated that were the earth in the form of a shell a body in the inside of it would not be attracted to one side of it more than another." C. J. WOODWARD.

Birmingham, February 26.

Barometric Oscillation.

IN my remark referred to by Mr. Braak (February 18, p. 459) I merely meant the increase of temperature which inevitably occurs when a gas is compressed. The compression and warming are simultaneous; this is shown in the passage of a sound wave where the air is compressed and warmed, and expanded and cooled alternately many hundreds of times in a second. If a barometric change is followed by a change of temperature at some subsequent time the result must be due to other conditions than those to which I alluded. W. H. DINES.

Life and Letters of Prof. A. Newton, F.R.S.

I HAVE been invited to write a life of the late Prof. Alfred Newton, F.R.S., of Magdalene College, Cambridge. If any of your readers who have letters or reminiscences or other interesting information about Prof. Newton will be kind enough to communicate with me, I shall be exceedingly grateful to them. I will, of course, undertake to return all letters, &c., to the senders.

A. F. R. WOLLASTON.

Savile Club, 107 Piccadilly, W., March 1.

THE ANTHROPOLOGY OF THE MURRAY ISLANDERS.[1]

NEVER, perhaps, has the anthropology of any people been studied so carefully and exhaustively as that of the islanders of the Torres Straits by the Cambridge Anthropological Expedition. Volumes have already been published on their physiology and psychology, on their linguistics, and on the sociology, magic, and religion of the western islanders. The present volume deals with the sociology, magic, and religion of the eastern islanders.

Under the somewhat vague term sociology are included chapters on folk-tales, birth and childhood customs, courtship and marriage, funeral ceremonies, trade, quarrels, and warfare, by Dr. Haddon; on genealogies, kinship, personal names, and social organisation, by Dr. Rivers; and on property and inheritance by Mr. Wilkin. The magic and religion are dealt with by Drs. Haddon and C. S. Myers.

The volume is full of the raw material from which a science of the psychological evolution of primitive societies may be built up, and is a model of careful and accurate methods of observation. In reading through the volume, however, one is impressed very much by the fact that the science of social psychology is still very much in its infancy. Is there anything, for example, in the race or in the environment which determines the peculiar character of these folk-tales? Dr. Haddon classifies them as nature myths, culture myths, religious myths, and tales about people. The difference in character between tales in different categories is not always obvious.

The studies in genealogies and kinship by Dr. Rivers approximate a little more closely to exact science. By painstaking inquiry the kinship of each individual in a fraternity is ascertained, and this forms the basis of valuable discoveries on regulation of marriage, taboo, &c. The Murray Islanders are exogamous, no marriages being permitted between contiguous villages. There appear to be certain definite functions attaching to kin; brothers or cousins preside at funerals, certain relatives can stop a fight, or take property without compensation.

The courtship and marriage customs are of considerable interest. The bride is stolen by the bridegroom from the house of the parents at night. "In the morning the parents would miss the girl and go in search of her. The *map le* then calmly informed them of what had happened, and the parents, calling on their friends to help, would rush off to the village of the abductor of their daughter brandishing their clubs and spears, and a fight would ensue, but very rarely was anyone injured. The lovers meantime remained in hiding pending the result of the fight." The parents are finally appeased by a payment made by the bridegroom and his friends. Polygamy is rare among the Murray Islanders, and polyandry is unknown.

The elaborate funeral ceremonies of the islanders are minutely described, and the authors remark that these ceremonies would occupy almost the whole time of the natives, if they were not dispensed with in the case of the very old and the young.

Law and government was formerly in the hands of the heads of a religious body known as the Malu fraternity, but has now been taken over by the Government of Queensland. The chief crime is wife beating. There appears to be a high standard of honesty in trade, as shown by the manner of purchasing a canoe, which is brought from a great distance and passes through the hands of a large number of intermediaries without any attempt to appropriate it or its price. A great deal of information is given about the native customs in trading which ought to be of considerable value to our traders.

The chapters on magic and religion will be of great interest to the students of these subjects. The authors endeavour to distinguish between magic and religion by the criterion that magical objects produce the required result automatically, while religious actions depend for their efficacy upon an appeal to some extra human influence of a more or less personal nature. They have to confess, however, that in some

FIG. 1.—A phase of the Ceremonial Dance of the Bomai-Malu *zogo le*. From vol. vi. of the Reports of the Cambridge Expedition to Torres Straits.

[1] Reports of the Cambridge Anthropological Expedition to Torres Straits. Vol. vi., Sociology, Magic and Religion of the Eastern Islanders. Pp. xx+316+30 plates. (Cambridge: University Press, 1908.) Price 21s. net.

ceremonies, such as the rain-making ceremony, the two are mixed up together.

Magical practices are in use among the natives to control the elements, to control vegetable life, to control animal life, and to control human beings. From this it may be inferred how important is the part that magic plays in the daily life of the native. To produce a good harvest, each plant or fruit has a special charm and ceremony. But magic may also be harmful, and is often used to injure an enemy or his property.

Religion, in the Murray Islands, appears to be chiefly represented by one important cult, known as the Bomai-Malu cult. A very strict secrecy is maintained about the ceremonies of this cult, but the

FIG. 2.—A phase of the Ceremonial Dance of the Bomai-Malu *zogo le*. From vol. vi. of the Reports of the Cambridge Expedition to Torres Straits.

authors appear to have succeeded in discovering everything of importance. The origin and nature of the ceremonies, their places and times, the participants, the ritual decoration, and ritual objects are all described at great length. The cult appears to have developed into a secret society or religious fraternity which has taken upon itself disciplinary functions. The cult includes initiation ceremonies for the young men, at which apparently some very good advice is given to the initiate.

There are a large number of valuable illustrations in the volume, including many figures in the text, and some thirty plates at the end. The work is produced in a manner which is highly creditable to the University Press.

THE CALIFORNIAN EARTHQUAKE OF 1906.[1]

WE owe so much to the activity of the institution founded at Washington by the generosity of Mr. Carnegie that it seems ungracious to find any fault, yet we must enter a plaint against the inconvenience of the form of publication which it has adopted. The instalment of the report on the California earthquake of April 18, 1906, now published, consists of two quarto volumes, of more than 450 pages in all, issued in paper covers, accompanied by an atlas which measures two feet in length and more than half a yard in breadth, a size which renders its accommodation in the libraries of most of those who will want to possess and use it a matter of great inconvenience, and necessitates its being stored and kept apart from the volumes which it accompanies. Yet this atlas might easily have been produced in a size that would match the text, for few of the twenty-five maps fill the whole of the sheets on which they are printed, and there are none which might not have been reduced in scale without any loss, and even in some cases with advantage; while those seismograms which could not be reproduced on a page of the same size as the text could have been folded, as is done by the Japanese Earthquake Investigation Committee, without any inconvenience.

Having given vent to this fault-finding we may turn to more congenial topics, and express our admiration of the thoroughness and completeness with which this important earthquake has been investigated and described. After a brief account of the geology of the region, we have a detailed account of that remarkable structural and topographical feature called the San Andreas Rift, which was closely associated with the earthquake. This rift follows a line of faulting, but appears to be the result of a different set of movements from those which produced the great up-and-down throw; for 600 miles, from Humboldt county, on the Pacific coast, to the Colorado Desert, it is marked by a narrow zone of depression, referable either directly to recent deformation of the ground or to erosion controlled by the lines along which this deformation has taken place. Though associated with faulting, often of great throw, as between opposite sides, the rift itself is a narrow strip containing a number of minor faults and fractures, running more or less in the same general direction, and dividing the ground into blocks of unequal size, which have sunk unequally between the margins of the rift. Throughout its length it is marked by steep scarps, generally of small height, ponds, and irregularities in the drainage lines which proclaim it as a region where earth-movement is recent or still in progress; and the greater earthquakes of the district are so commonly accompanied by movement along the rift that it has acquired the local name of "earthquake crack." In 1906 the movement was confined to about 190 miles at the northern end of the rift line, and, as revealed at the surface, appeared in different forms; at times there was but a single fissure, hardly discernible except by its effect in breaking and displacing roads and fences, at others there were several roughly parallel faults, and again, where the rock was covered by surface accumulations or alluvium, there was a series of fissures running obliquely, but arranged in

1 "The California Earthquake of April 18, 1906." Report of the State Earthquake Investigation Commission." By Andrew C. Lawson, Chairman, in collaboration with G. K. Gilbert, H. F. Reid, J. C. Branner, H. W. Fairbanks, H. O. Wood, J. F. Hayford, A. L. Baldwin, F. Omori, A. O. Leuschner, George Davidson, F. E. Matthes, R. Anderson, G. D. Louderback, R. S. Holway, A. S. Eakle, R. Crandall, G. F. Hoffman, G. A. Waring, E. Hughes, F. J. Rogers, A. Baird, and many others. 2 vols. Pp. xviii+451; 146 plates, 66 illustrations in text; atlas of 25 maps and 15 sheets of seismograms. (Washington: Carnegie Institution, 1908.)

echelon, so that the band of fissuring followed the general run of the movement in the underlying rock.

Following on the description of the surface movements along this rift, and the account of the retriangulation of the country on either side of it, is a detailed description of the distribution of the violence of shock, and discussion of the course of the isoseismals.

FIG. 1.—Characteristic Rift features south-east of Fort Ross. Fault-trace in foreground.

These have a peculiar distribution; the maximum violence was along a narrow band closely adjacent to the rift line, where surface displacements were greatest, but the progressive diminution of violence, as this line is left, is interrupted by a number of isolated areas of destructive violence. In discussing the explanation of these isolated centres of increased violence, the conclusion is reached that they are due to variations in the nature of the ground, and to be attributed to the well-known fact, illustrated by some interesting experiments contained in the report, that earthquakes are commonly more destructive on alluvium or made ground than on rock; but in attempting to ascribe all the irregularities in the course of the isoseismals to this cause, we cannot but feel that the committee, or, rather, its chairman, has given its support to an obsolescent theory. So many instances are now known of extended origins, and of earthquakes with more than one centre of maximum violence, that an attempt to refer an earthquake to a single centre of origin is no longer justifiable unless this hypothesis is easily reconcilable with observation. In this case it seems more reasonable to accept the isolated centres of destruction, or of increased violence, as independent centres of origin of the same great earthquake, not of separate local earthquakes, as suggested and controverted in the report.

The experiments, to which reference has been made, are of great interest, and throw light on some little understood earthquake phenomena. They were made with a shaking table, set in motion by a crank and connecting-rod, of the same type as that employed in the Japanese experiments on the overturn of columns; the table carried a box which was filled with sand or gravel, dry, or mixed with different proportions of water, and determinations were made of the amplitude and character of movement of the surface of the sand as compared with that of the table. With closely packed dry sand there was little difference, but with wet sand the amplitude was greater, and, what is more important, the reversal of motion much more abrupt, giving an acceleration which, in one experiment, was more than three times as great as that of the table. We have here a suggestion of the reason for this fact, which has often been observed, that the destructive effect of an earthquake is greater on alluvium near its junction with rock than on the rocks or further out on the alluvium, and it is to be hoped that this very interesting and suggestive line of experiment may be followed up more fully than was possible in time for the publication of the report.

Only a few of the more striking features of this report have been referred to; it would be impossible to deal in detail with the discussion on scales of intensity, the direction of vibratory movement, the effect of the shock on men and animals, and the many other matters described with a prolixity of detail, and "exprest" in a language which, with thankfulness be it said, has not yet become "thrly" unintelligible to the average Englishman.

FIG. 2.—Ponds along Rift near San Benito.

RADIO-THORIUM.

DURING the past week accounts have appeared in the daily papers of a discovery emanating from America of "a new rival to radium" called radio-thor; and as in name and in the circumstance that the body is spoken of as a cheap substitute for radium the body bears obvious resemblance to radio-thorium, well known as one of the most interesting and promising members of the radio-active hierarchy at the present time, it may be of interest to compare the two bodies.

It is obvious that the resemblance begins and ends with the two points referred to. Radio-thor, we read, was discovered by Dr. Bailey, of Hahnemann Medical College, Chicago, in pitchblende from Colorado. It is stated in the recent report with which the public has been favoured, that the new body possesses all the curative properties of radium and none of its baneful after-effects, that the supply is apparently unlimited, and that it is within the reach of persons of moderate means. When placed in contact with the negative pole of a magnet it becomes luminous (!); it colours common glass like Bohemian glass; and is of immense value financially. Dr. Bailey, adds the account, claims to have discovered a positive remedy for locomotor ataxy, cancer, and other maladies that have long baffled the medical profession. The prolongation of life and the cure of all ills by its aid are also referred to airily by a colleague.

It is a relief to turn from this monotonously familiar exploitation of knowledge to the radio-thorium of science, the intensely radio-active product of thorium, giving α rays, first separated from the new Ceylon mineral thorianite, which consists mainly of thorium oxide, by Otto Hahn while working in Sir W. Ramsay's laboratory. Its period of half-change was determined to be two years by G. A. Blanc, who independently separated the substance from the sediments of the hot springs of Baden-Baden. The subsequent developments formed as fascinating a chapter of progress as any in radio-activity. The first product of thorium to be separated and recognised was the thorium X, of period four days, which Rutherford and Soddy found was left in solution when thorium is precipitated by ammonia. We know now it is the product of radio-thorium, which in this separation, as always, remains with the thorium. So closely allied are they in chemical nature that even to-day no process is known of separating them. Yet both thorium and radio-thorium are known alone because though the one is the product of the other, it is not the direct product.

There is an intermediate body, "meso-thorium," produced from thorium, and producing radio-thorium. Its period is not yet accurately known, but is estimated at seven years. It gives β rays only. Boltwood showed that in the ammonia separation referred to the meso-thorium goes with the thorium X, and leaves the radio-thorium with the thorium. In the course of a few years the radio-thorium all changes, leaving thorium alone, while the meso-thorium grows new radio-thorium, readily separable as before. In all probability all the radio-thorium yet prepared is not ready-made radio-thorium separated from thorium, as the investigators first thought, but re-formed radio-thorium produced during the separation from the easily separable meso-thorium.

As the result of these researches it was suggested by Rutherford that meso-thorium and its spontaneously appearing family of products—radio-thorium, thorium X, &c.—might serve as a cheap and effective substitute for radium for many purposes. In the Welsbach gas-mantle industry thorium salts are manufactured by the ton. The readily separable meso-thorium plays no part in the commercial application of thorium, and could be removed without injury to the product and with no appreciable waste of the substance during the manufacturing process. At first it would only give β rays, but in the course of a few years α radiation would make its appearance as radio-thorium and its products were formed. The substance would then comprise practically the whole of the radio-activity of as large amounts of thorium in as small amounts of matter as desired. For most purposes such a body would be as valuable as radium. The activity, it is true, would not be permanent, like radium essentially is, but it would last a good many years—long enough to be very useful—and its cheapness and the practically unlimited supply of it would compensate for this lack of permanence. It is to be hoped that the thorium manufacturers of Germany and America are following up this suggestion.

FREDERICK SODDY.

THE POOR LAW COMMISSION REPORT.

IT might be thought that this document would hardly furnish matter for consideration in a scientific journal, but those who have given the closest attention to subjects of poverty and public assistance are getting to be more and more convinced that it is to scientific study and the application of scientific principles, in other words, to the cultivation of a scientific spirit, that we have to look for the best remedies of the various evils of social life, and that it is by the want of that spirit that those evils have grown up.

The report in question will probably rank in future as an economic State paper of as great importance as that of 1832, upon which the reform of the Poor Law in 1834 was based. That report bore fruit for many years in a gradual reduction of the number of paupers and the volume of pauperism. Recently a reaction has taken place, and the number of paupers and the volume of pauperism have increased. The conclusion is irresistible that considerations other than scientific ones have been allowed to have undue weight.

The present report defines the principles upon which the poor law reform (incorrectly printed as "report" at pp. iv, 53, 80) of 1834 proceeded, as follows:—

(1) That relief should not be offered to able-bodied persons and their families otherwise than in a well-regulated workhouse.

(2) That the lot of the able-bodied should be made less eligible than that of the independent labourer outside.

With these principles there can be no quarrel, and to their having been carried into effect with more or less fidelity during the greater number of the years that followed must be attributed the decline in pauperism to which we have adverted. It is to the gradual weakening of these principles in later years that the reaction towards an increase in pauperism is due. The causes of this reaction and the remedy for it constitute the real problem which was submitted by the King in 1905 to the Commission which has just made its report after a patient investigation occupying more than three years.

One source of the failure of the present system has undoubtedly been the inefficiency of the local authorities charged with its administration. The boards of guardians are elected by popular vote, but that election attracts little popular interest. In London somewhat more than a quarter of the electorate trouble themselves to vote for a guardian, while nearly three times as many will vote for a member of Parliament. The result is that men are sometimes returned on those boards who are ignorant of the laws they are selected to administer, and who have other reasons for seeking

election than their knowledge of or interest in the poor. Accordingly their administration is often faulty and ill-informed; and the Commissioners direct attention to many cases in which the allowances made by the guardians are helping to perpetuate social and moral conditions of the worst type. Even when the relief is given to the right people, it is too often inadequate in amount, and ill-adapted to the particular needs of the case.

The object of the Commissioners, therefore, is to ensure that henceforth the local public assistance authority shall be largely nominated from amongst men and women of experience, wisdom, and unselfish devotion to the public good, and shall be served by officers fully qualified by knowledge and by experience. For the higher offices it is suggested that there should be qualifying examinations, and highly trained officers will be required in what are now regarded as less important posts, *e.g.* that of labour master. For these purposes a graded public assistance service should be set up, which should include all officers concerned with the supervision, control, and disciplinary treatment of the poor, both male and female. In this service there should be more opportunity of promotion from the lower to the higher ranks, and no question of superannuation should hinder the transfer of efficient and promising officers from one local authority to another.

The recommendations of the Commissioners tend not merely to securing better qualified administrators, but also to the adoption of sound principles, which we may fairly define as scientific, in the distribution of public assistance. For example, the principle of classification is insisted upon, in institutions adapted to the various needs of the dependent poor, in lieu of the aggregation of all classes in the present workhouses. For those trespassers on public hospitality called "ins-and-outs" a system of detention should be adopted. Outdoor relief should be administered under those conditions of strict investigation and adaptation to the particular needs of the individual which are expressed in the term "case-work," and in such a manner as to strengthen the hands of sanitary authorities, and to elicit the support and cooperation of voluntary aid committees. The aged should be adequately relieved, and their comfort and happiness considered. Many recommendations are made as to the care, education, and medical supervision of children. The detention of feeble-minded, idle, and immoral paupers is recommended, and is a step which may help to the solution of a problem in eugenics.

Among the questions dealt with in this report for the determination of which the scientific spirit is essential, that of the relation of public assistance to voluntary aid—that is to say, of the relative functions of the community, of the charitable individual, and of the charitable foundation in the relief of distress—is one of the most important. Its consideration occupies eighty folio pages of the report, and we are glad to know that it has not been omitted from the programme of the British Science Guild, which has, at the suggestion of Sir William Bousfield, appointed a committee to work out this problem. The report will supply materials of great value to that committee. It bears testimony to the good results obtained by the labours of charity organisation societies in all parts of the country, which have long been imbued with that spirit; and it leads to nineteen specific recommendations, too minute to be referred to in detail, which justify the hope that that spirit will govern the administration of public aid and of charity in the future.

The report of the four members of the Commission who found themselves unable to sign that agreed to by their fourteen colleagues also confirms the views we have endeavoured to express. It declares the breaking up of the present unscientific category of the aged and infirm, and the substitution of a method of dealing separately with distinct classes according to the age and the mental and physical characteristics of the individuals concerned, to be a necessary preliminary of any effective reform.

Other problems which are discussed in these able documents require actuarial science for their solution, as, for example, the distress due to unemployment, invalidity assurance, old age pensions, friendly societies and trade unions, and the other provident institutions which have been so marvellously efficient as prophylactics against pauperism; but space will not allow of further discussion. Enough if we have shown the place of the scientific spirit in dealing with a great social and economic question.

THE METEORIC FIREBALL OF FEBRUARY 22 AND ITS STREAK.

ONE of the most notable meteors of recent years appeared on February 22 at 7.30 p.m., and was observed from the southern counties of England. It was a brilliant object, at first emitting an orange light, varying in intensity, then when about half its flight had been performed it suddenly blazed out with a steely-blue lustre and lit up the foggy atmosphere as though a huge rocket had exploded. It left a short, luminous streak where the chief outburst occurred, but this streak immediately intensified and soon extended along the whole path traversed by the meteor. Becoming bent and contorted, it assumed a variety of shapes and drifted to north-west under the action of upper wind currents. Diffusing itself into a broad, faint band of irregular form, it was ultimately lost amid the Milky Way about two hours after the time of its first projection. The long duration of the streak is almost without parallel in this country, though the Madrid meteorite of 1896 February 10 left a luminous band or cosmic cloud visible in the sky for 5½ hours!

The meteor of February 22 was a Leonid, but the radiant is not quite accurately defined, as the flight of the object was very similar at most of the stations, for it slightly descended from Canis Minor to the southern region of Orion. But there is no doubt that the direction was from Leo, and the point of radiation seems well indicated at 175°+16° near β Leonis. Just possibly the radiant may have been at 155°+12°, for I saw a fairly bright meteor on the same night passing slowly from 150°+40° to 148°+49°, and directed from this centre 5° E. of Regulus. The height of the large meteor was from about sixty to twenty-six miles over the English Channel, about forty miles south of the coasts of Sussex, Hampshire, and Dorset. The luminous course was about 135 miles in length, and the velocity 20 miles per second. Several observations indicate a greater length of path and a lower elevation (22 miles) at the end, vertically over a point 50 miles S. of Plymouth. The best estimates for the duration of flight are 5–6 secs., 6–7 secs., and 8 secs. The fireball of 1898 February 20 had a radiant at 177°+12°, and probably belonged to the same system.

As to the trail, at 8h. 12m. one trustworthy observer says the whole length of it was 100°; another gives 180°. Many excellent observations are to hand, and it may be possible to work out some interesting details concerning the velocity and direction of its drift. The great changes which affected it will, however, make this difficult. One bright bend in the luminous

material moved to N.W. at a rate of eighty miles per hour, and appears to have retained approximately the same height of thirty-two miles while it travelled from over a point N. of Alderney Island to over Dartmoor. The streak of the fireball of 1894 August 26 moved to S.E. at a rate of 120 miles per hour, and was about fifty-one miles high. In fact, meteoric streaks from the swifter class of objects, such as Leonids, Perseids, and Orionids, are usually between fifty and sixty miles high. The streak or smouldering residue of the February 22 fireball was much lower than this, though the earlier portions of it exceeded fifty miles in height.

The burning or phosphorescence of the meteoric débris for so long a period after dispersion is remarkable. Moonlight could hardly have produced the effect, as our satellite was only 2¼ days old (setting at 8h. 19m.) and reflected little light. I have never observed meteor streaks to have a lengthened existence in the presence of the full moon, so that another cause inherent in the glowing material must be found for its extraordinary sustenance in the recent case. There must have been something special in its composition or in the condition of the air at the time.

I have received seventy-one observations of the meteor or of its trail, and other descriptions of very useful character ought to come from Havre, Cherbourg, and other places on the north coast of France and from the Channel Islands.

The phenomenon may be aptly described as *the* meteoric spectacle of a generation. As the nucleus sailed along its nearly horizontal course, its light was far from being even. It gave a series of outbursts, the brighter of which much exceeded the lustre of Venus. This comparison applies to a distance of 100 miles. The mate of a vessel in the Channel near Start Point says the light was astonishing, and broke out with startling vividness, so that anyone could have easily seen to read.

At the end of the meteor's flight it seemed to turn abruptly in its direction, and fragments or embers fell almost vertically earthwards about 3°. Then the trail bent to the east and extended rapidly in a horizontal path. The rate of this easterly drift, as seen at Dunstable, Farnham, and other places, was shown on drawings, and appears to have been more than 300 miles per hour, the visible length having increased about eighty miles between 7h. 30m. and 7h. 45m. Something more than mere wind currents would appear to have been instrumental in inducing this rapid translation. The easterly streak appears, in fact, to have occupied at 7.45 the place where the original train existed at 7.30, but which had risen about 20° a quarter of an hour later.

The nucleus of the meteor as it traversed its course threw off a train of fiery sparks, such as is often seen, but these quickly died away. Then slowly the durable streak or trail came out, intensifying rapidly and stretching across the sky like a silver ribbon very irregularly arranged. By one observer in the Channel it was watched for three hours, until it became faintly blended with the Milky Way in Cepheus and Cygnus.

The bend in the path of the fireball at the limits of its westerly flight and the remarkable streak which quickly formed far to the east are curious. It has been suggested that there may have been a second meteor responsible for the lower streak stretching to the eastward. But as hundreds of persons were watching the sky, it would have been and reported had it been visible. At the termination of the meteor's career it evidently suffered disruption by two violent explosions, the places of which were definitely marked by brilliant condensations at the angles of the bent streak. Is it possible that on the bursting and disintegration of the mass one large fragment was hurled in a direction nearly opposite to that of the original course? The resistance of the air at the comparatively low altitude of the meteor must have been considerable in checking its velocity, but some more potent influence must have suddenly stayed the westerly rush of the object, diverted it or its material earthwards, and then, as abruptly, dispersed it far and rapidly eastwards.

W. F. DENNING.

NOTES.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society:—Mr. E. C. C. Baly, Sir Thomas Barlow, Bart., Rev. E. W. Barnes, Dr. F. A. Bather, Sir Robert A. Hadfield, Mr. A. D. Hall, Dr. A. Harden, Mr. A. J. Jukes-Browne, Prof. J. G. Kerr, Prof. W. J. Lewis, Prof. J. A. McClelland, Prof. W. McFadden Orr, Dr. A. B. Rendle, Prof. J. Lorrain Smith, and Prof. J. T. Wilson.

THE *Times* announces that a well-equipped aërodynamic laboratory is about to be established by the Aéro Club de France with the assistance of the State. It is computed that more than 5000*l.* will be required to start this project, the utility of which is unquestioned. Practical tests in planes, propellers, engines, &c., will be carried out at this laboratory.

THE seventh annual session of the South African Association for the Advancement of Science will be held at Bloemfontein during the week ending October 2, under the presidency of Sir Hamilton J. Goold-Adams, K.C.M.G. The assistant general secretary is Mr. E. Hope Jones, P.O. Box 1497, Cape Town.

THE sixth International Psychological Conference will be held at Geneva from August 3 to 8 next. An exhibition is being arranged, and a special section is to be devoted to animal psychology. M. E. Claparède, 11 avenue de Champel, Geneva, is the general secretary, and M. Cellerier, Montchoisy, Geneva, is the treasurer.

THE Paris correspondent of the *Daily Chronicle* states that the wireless telegraph station on the Eiffel Tower has been receiving messages from the station at Glace Bay, Canada, a distance of 3250 miles. A new installation is being fitted at the Eiffel Tower, by means of which it is hoped to establish wireless telegraphic communication with Saïgon (Cochin China), a distance of 6800 miles.

ON Thursday next, March 11, Mr. A. D. Hall will begin a course of two lectures at the Royal Institution on "Recent Advances in Agricultural Science." The Friday evening discourse on March 12 will be delivered by Mr. S. G. Brown on "Modern Submarine Telegraphy," and on March 19 by Mr. R. Threlfall, F.R.S., on "Experiments at High Temperatures and Pressures."

THE Berlin correspondent of the *Times* announces the death of Prof. H. Ebbinghaus, professor of philosophy at the University of Halle, at fifty-nine years of age. Prof. Ebbinghaus contributed extensively to the *Zeitschrift für Psychologie*, of which he was the founder, while of his several books the best known are his work "On the Memory" (1885), and the first volume, which appeared three years ago, of the unfinished "Principles of Psychology."

AN exhibition of optical and ophthalmological appliances will be held in the rooms of the Medical Society of London on March 12 and 13, from noon to 10 p.m. each day.

MUCH interest is being taken in the International Aëronautical Exhibition which will be opened at Frankfurt a. M. in the beginning of July next. Four sheds will be reserved for airships, which will make ascents, with passengers, from the exhibition grounds. Frequent ascents will also be made by ordinary balloons, and various aëronautical societies have been invited to take part in them. Flights with aëroplanes, in which some of the best-known aviators will compete, promise to be of special interest. Industries connected with aëronautics will be represented, and one section will be devoted to inventions and apparatus of the past. Wireless telegraphy and carrier pigeons will be employed for communications to and from the exhibition, and some prizes of considerable value will be awarded.

TELEGRAPHIC messages from Havana through Reuter's Agency announced that on February 27, beginning at 11.21 a.m., the seismograph there was disturbed intermittently for forty minutes. The earth waves moved from east-north-east to west-south-west. A message from Palmi, Calabria, on the same date states that a violent earthquake shock was felt there at 1.50 a.m., and that two other shocks followed later. From the same source it is reported that a slight shock was felt at Reggio di Calabria at 6.45 p.m. Reuter further reports that soundings taken in the Straits of Messina and in the ports of Messina and Reggio di Calabria show that no alteration in the ocean floor in those parts or in the coast-line was caused by the recent earthquakes. Prof. Milne recorded at Shide, Isle of Wight, on February 27, at 4.58 p.m., an earthquake of great intensity, which was at its maximum at 5.36 p.m. The origin of this disturbance was about 5000 miles distant.

THE thirty-first annual general meeting of the Institute of Chemistry was held on Monday, March 1, Prof. Percy F. Frankland, F.R.S., the retiring president, in the chair. In his presidential address, Prof. Frankland emphasised the fact that whilst the well-being of the community is greatly promoted by the services of competent chemists, the mischief which can be wrought by the ill-trained and incompetent is incalculable. It is one of the chief duties of the institute to maintain a high level of training for professional chemists by demanding of candidates for its membership evidence of thorough training, and by requiring them to pass searching examinations. Particular attention has been given lately to the educational side of the institute's activity. Referring to research, Prof. Frankland reminded the fellows that the results of research are not necessarily recorded in the Transactions or Proceedings of a scientific society or journal. There is a vast amount of research involving originality and attainments of the highest order which from its very nature cannot be published at all. Many chemists whose names are not associated with academic researches are nevertheless fully equipped and highly original investigators. There is much training in originality of thought and experimental procedure which is not called research, and much of what is called research involves no originality in the thought or deed. After congratulating the institute on the choice of Dr. George T. Beilby, F.R.S., as the new president, Prof. Frankland thanked the fellows and associates for their kindness and consideration during his term of office. On behalf of the fellows and associates the president then presented an illuminated address to Mr. David Howard, in recognition of his services to the institute in various capacities, as member of council, honorary treasurer (eighteen years), president, vice-president, and censor, extending altogether more than thirty years, at the same time congratulating him on the approach of his seventieth birthday, while yet retaining remarkably his health and vigour.

THE Elizabeth Thompson Science Fund, to which reference has been made in previous years in these columns, established "for the advancement and prosecution of scientific research in its broadest sense," now amounts to 5200*l*. As accumulated income will be available next month, the trustees of the fund desire to receive applications for grants in aid of scientific work. This endowment is not for the benefit of any one department of science nor for men of science of any particular nationality, but it is the intention of the trustees to give preference to investigations which cannot otherwise be provided for, which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Applications for assistance from the fund must be accompanied by full information as to the precise amount required, the exact nature of the investigation proposed, the conditions under which the research is to be prosecuted, and the manner in which the grant asked for is to be expended. All applications must reach, before March 15, the secretary, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U.S.A. Decided preference will be given to applications for small amounts, and grants exceeding 60*l*. will be made only in very exceptional circumstances. Prior to 1898, eighty-one grants were made, and of these seven only have yielded no published result. Since 1898 sixty-five further grants have been made, and the work aided by some of them is still unfinished.

THE weather report for the week ending last Saturday, February 27, shows that the temperature over England was considerably below the average, especially in the south, the deficiency in the south-east of England amounting to 5°·4. In the south-west and south-east of England the shade temperature fell below 15°. At Greenwich the thermometer in the sun's rays registered 97° on February 22, whilst during the preceding and following nights the exposed thermometer on the grass registered 11°. The lowest shade temperature for February was 19°, on the morning of February 23. The mean temperature at Greenwich for February was 37°, which is about 2°·5 below the average of the previous sixty years. Frost occurred in the open each night with the exception of February 4 and 5. The rainfall was less than one-half of the normal, whilst the sun was shining ninety-one hours, which is thirty-four hours more than usual. The summary given by the Meteorological Office for the thirteen weeks which constitute the winter, ending February, shows that the mean temperature was generally below the normal, the extreme readings ranging from 59° in the south of Ireland, and 58° in the east of Scotland and the east of England, to 3° in the Midland counties and the south-east of England. The rainfall was deficient over the entire kingdom, the deficiency ranging from 4·21 inches in the south-west of England to 0·24 inch in the north of Ireland. The duration of bright sunshine was generally in excess of the average, especially over the southern portion of England. At the close of February and on the opening days of March a touch of real winter was experienced over the entire area of the British Islands, as well as generally over western Europe; sharp frosts occurred in all parts, with heavy snow.

THE Bill "to promote the earlier use of daylight in certain months yearly"—formerly known shortly as the Daylight Saving Bill—is down for the second reading in

the House of Commons to-morrow (Friday). The Bill represents the shape of the resurrection of a measure which passed its second reading in the House a year ago, and was referred to a select committee. The unscientific character of the proposal and the confusion which would follow should the measure ever find a place in the Statute-book were stated clearly in NATURE of July 9, 1908. To the views expressed in that article most competent authorities will subscribe. For the sake of history, we give the substance of the measure, but it is difficult to believe that the House of Commons will consent to the system of self-deception which is advocated by the promoters of the Bill, with complete disregard of the consequences. The operative clauses of the Bill are as follows:—(1) From two o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of *the third Sunday in April* in each year until two o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of *the third Sunday in September* in each year the local time shall be in the case of Great Britain one hour in advance of Greenwich mean time and in the case of Ireland one hour in advance of Dublin mean time, and from two o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of *the third Sunday in September* in each year until two o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of *the third Sunday in April* in each year the local time shall be in the case of Great Britain the same as Greenwich mean time and in the case of Ireland the same as Dublin mean time. (2) The time hereby established shall be known as summer season time in Great Britain and Ireland, and whenever any expression of time occurs in any Act of Parliament, deed, or other legal instrument, the time mentioned or referred to shall, unless it is otherwise specifically stated, be held in the case of Great Britain and Ireland to be summer season time as prescribed by this Act. (3) Greenwich mean time as used for the purposes of astronomy and navigation shall not be affected by this Act. (4) This Act shall apply to the United Kingdom of Great Britain and Ireland, and may be cited as the Summer Season Time (Great Britain and Ireland) Act, 1909.

IN the course of a paper published in vol. iv., Nos. 1 and 2, of the *Bio-chemical Journal* on the relations of certain marine organisms to light, Prof. B. Moore directs particular attention to the periodicity of their phosphorescence. That light from without influences this phenomenon is demonstrated by the fact that the periods of activity and rest in regard to phosphorescence follow, respectively, the hours of daylight and darkness. How deep-seated is this periodicity has been demonstrated by experiments on copepods, in which it persisted for no less than twelve days in the absence of the accustomed recurring stimulus of nocturnal darkness and diurnal light. It is added that the phosphorescence of these copepods in captivity is spontaneous, and although increased by mechanical stimulation, goes on vigorously even when the organisms are at rest and undisturbed.

THE February number of the *Zoologist* contains a remarkably interesting account, by Mr. H. W. Bell-Marley, of hunting the hump-backed whale in Natal waters. For some years it has been observed that between May and August large numbers of hump-backs pass between Natal and the Delagoa Bay coast, and in May, 1908, some enterprising Norwegians obtained permission to set up a whaling-station on the Bluff side of the channel. Their success may be judged from the fact that between July and the early part of September no fewer than one hundred and two hump-backs and two rorquals were taken. The supply is, however, not exhausted, as the writer describes steaming into the midst of a school of about a score of these monsters, the movements and gambols of which afforded a most wonderful and thrilling spectacle. Nevertheless, such vigorous fishing cannot long be carried on without seriously diminishing the numbers of the whales, and Mr. Bell-Marley is of opinion that, if their extermination is to be prevented, action ought forthwith to be taken by the Colonial Government.

AN interesting pamphlet, written by Mr. H. A. Ballou, has just been issued by the Imperial Department of Agriculture for the West Indies on "millions" and mosquitoes. Millions are small fishes, the full-grown female measuring about 1½ inches in length, while the male is much smaller; they belong to the species Girardinus, the particular variety dealt with in the pamphlet being *G. poeciloides*, De Filippi. They live in shallow water, and are such voracious feeders on the eggs, larvæ, and pupæ of mosquitoes that these insects are unable to breed in streams and ponds stocked with them. They commonly occur in Barbadoes, and in consequence the Anopheles mosquito, which disseminates malaria and breeds only in shallow streams, pools, or marshes, has never been able to spread, and Barbadoes is free from malaria. The Imperial Department has since 1905 made shipments of these fishes to several West India islands, and from all sources favourable reports have been received. At Antigua the Board of Health has undertaken the work of stocking all the ponds and streams, and the mosquito nuisance has abated in consequence. It is pointed out, however, that certain varieties of mosquitoes, *e.g. Culex fatigans* and *Stegomyia fasciata*, breed in small temporary collections of water, such as those found on house-tops, in rain-water tanks, bottles, the concavities of leaves, &c., and will therefore escape destruction by the "millions."

DARWIN and the mutation theory form the theme of the opening article, by Mr. C. F. Cox, in the February number of the *American Naturalist*. After mentioning that the great evolutionist would not have accepted, at least in its entirety, the mutation theory of de Vries, the author states that "he was compelled to concede that what we now call mutation had occasionally taken place and become the starting point of new races, but he was none the less unshaken in the conviction that this process was exceptional and extraordinary, and that, as a rule, a new species originated by the gradual building up of minute and even insignificant deviations from the average characters of an old species. . . . For the doctrine of 'insensible gradations,' which touched mainly a minor premise in his general argument for evolution, Mr. Darwin was almost willing to relinquish the essence of the whole matter, which was his claim to the discovery of a *vera causa* in the evolutionary process. . . . The establishment of the theory of natural selection was Mr. Darwin's greatest and most original achievement. Time has proved that he could have afforded to stand upon the general validity of this theory, though everything in his argument in its favour had needed review and modification. . . . Properly regarded, the mutation theory does not antagonise or weaken the doctrine of natural selection—on the contrary, it merely offers itself as a helpful substitute for, or adjunct to, one of Darwin's subordinate steps in the approach to a consistent philosophy of the origin of species, leaving the great cause of

evolution as efficient as ever. It is, therefore, one of the tragedies of science that in this matter Darwin should have been ready to surrender his main position rather than to receive and to join forces with those who were coming to his aid."

IN the number of *Man* for February Mrs. M. E. Cunnington describes the result of the excavation of a late Celtic rubbish-heap near Oare, in Wiltshire. From the number of potsherds unearthed it was supposed by some authorities that the mound represents the accumulated débris of a pottery; but there are no signs of distortion during baking in any of the fragments, and the number of animal bones points to the existence of a considerable settlement. The pottery falls into two classes, that of native manufacture and that imported. Most of the examples of the former type are not inelegantly shaped bowls with a contracted mouth and bead rim. These are of purely British manufacture, and are characteristic of the late Celtic period, like the examples from Weymouth in the British Museum and those of the same period at Colchester. The foreign ware is of various types—Belgic of the first century A.D., green-glazed Roman ware from Gaul, and several pieces of very thin white and cream-coloured pottery, which probably came from Rheims about the same time. More remarkable are examples of the rare Arretine ware, while the absence of the later Gaulish red Samian corroborates the date of this accumulation, which seems to have been made just before the Roman occupation of that part of the island. If the date of the neighbouring Martinsell Camp could be established, it is possible that its garrison may have had some connection with the inmates of this settlement.

THE *National Geographic Magazine* for January continues its campaign against the destruction of the State forests of America by lessons drawn from two countries of the old continent. Mr. E. L. Harris, in his notes on the buried cities of Asia Minor, shows that in the neighbourhood of Pergamus the ruin has been so widespread that it is doubtful if any rational system of forestry can now restore the trees which once covered the higher grounds and permitted a flourishing agriculture in that region. Mr. F. N. Meyer points out that in a large part of northern China, which in the time of Marco Polo was the seat of extensive silk culture, the mulberry trees have disappeared, the rivers once used for carriage of goods have shrunk in volume, and the deserted wells bear witness to the shameful destruction of the forests. The denudation of the hill-sides is said to have diminished the rainfall, the soil on the slopes has disappeared, and disastrous floods result from the rapid dissipation of the water in the rainy season. Here, too, the mischief seems to be almost past remedy, and unless the Chinese Government takes immediate and active measures the eastern extension of the Mongolian desert is inevitable.

THERE is certainly room for a popular, well-illustrated periodical dealing with the lighter side of geographical work, and this want seems likely to be supplied by the new magazine *Travel and Exploration*. The March number contains articles by competent writers describing expeditions in many parts of the world. The best of these is that by Lord Hindlip on a hunting trip in the Nahlin or Cassiar mountains, near the famous Dawson Trail leading to Klondike, in which he was successful in obtaining fine specimens of the wild sheep. Miss E. C. Sykes is also a little off familiar ground in her account of a ride along the little-known route in northern Persia from Meshed to the railway line which runs between Merv, Askabad, and Krasnovodsk. The scheme of this new periodical includes reviews of current geographical literature, which, it may be hoped, will soon develop into an adequate bibliography.

A SUMMARY and bibliography of literature dealing with Russian botany, that was published in 1906, has been issued as a supplement to the *Bulletin du Jardin impérial botanique*, St. Petersburg. The contents are, it may be mentioned, practically inaccessible except to Russian scholars.

SIR JOSEPH HOOKER has made a further contribution to the classification of the genus Impatiens in the first number of the *Kew Bulletin* for the current year, where he furnishes a description of species from Indo-China and the Malayan Peninsula. The comparison of selected characters leads to the conclusion that the species from these regions are closely allied, and show some affinity with Burmese species, but differ greatly from the Chinese. Four of the specimens are made the types of new species. Another systematic article is provided by Mr. T. A. Sprague, being a revision of the section Omphacarpus of the genus Grewia.

DR. M. SAMEC communicates to the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften* (vol. cxvii., part v.), Vienna, a note on the variation in the intensity of light at different altitudes. During a balloon journey he took a series of readings for comparison with measurements made by Prof. Wiesner in the course of his investigations regarding the amount and nature of the light falling upon plants. Readings were taken of the intensity of sun-light and of diffused light. The figures are somewhat irregular, but the intensity of sun-light increased with ascent, and more rapidly than the intensity of the diffused light. The measurements of light reflected from below showed a series of maxima corresponding with the passage of the balloon over water.

AN account of the constructive work for restraining the flow of torrents and of the *reboisement* of mountain slopes near Interlaken contributed by Mr. C. E. C. Fischer to the *Indian Forester* (January) should indicate to the authorities in India the value attached to such precautions in Switzerland, and may possibly help towards the establishment of a similar policy. Although avalanches and storms are important factors in denudation, the prime agent is the browsing goat. The chief features in construction are the retaining walls built at intervals across the valley, the channels for leading off the streams, and wattle fences for checking the downward flow. Grass is planted between the fences, and prepares the ground for early settlers such as *Sedum annuum* and Adenostyles; later on, Parnassia, orchids, aconites, and other plants appear on the scene, and in two or three years alders or pines may be planted.

WE have received a discussion of the winds at Rome by Dr. I. Massarini, deduced from anemograph records for 1876–1905, and reprinted from the Annals of the Italian Meteorological Office, vol. xxvii., part i. The author has dealt with the subject in great detail, and has calculated, *inter alia*, the frequency of wind direction under sixteen points and their velocity with respect to the hours of the day, as well as for months, years, and for periods of ten and thirty years; also the velocity for the same periods, irrespective of direction, and has exhibited the results in fifty-four tables and nine plates. We can only note here the following general remarks:—(1) Direction. The most frequent winds are (in order of their frequency) N.N.E., N., and S.; the least frequent is the E. wind. (2) Velocity. The strongest winds are S.S.E., S., S.S.W., and N.N.E.

(the last two having equal values). The weakest wind is from N.W. During three years, 1873–5, a Robinson anemometer was in operation; the author has supplemented his valuable work by a separate discussion of these data.

THE Memoirs of the Indian Meteorological Department, vol. xx., part v., contain a laborious and valuable analysis, by Mr. R. L. Jones, of the records of the anemograph (Meteorological Office pattern) at the Madras Observatory for eleven years, 1865–75. The tables give (1) the mean hourly movement of air, irrespective of direction, for each hour of the mean day of each month and for the year, and the constants of the periodical formulæ; (2) mean hourly southerly and westerly components, and the constants of the periodical formulæ, with computed values in each case. The chief features of the mean monthly air movement (irrespective of direction) are (*a*) a nearly uniform increase during the hot-weather period; (*b*) a more or less uniform decrease approximately during the south-west monsoon period; (*c*) a nearly uniform increase during the transition period; (*d*) a nearly uniform decrease approximately during the cold-weather period. The curves showing the daily variations exhibit a general resemblance to the daily variations in air temperature. The resultant air movement deduced from the southerly and westerly components is (1) between north and east during the transition and cold-weather periods; (2) between east and south during the hot-weather period; and (3) between south and west during the south-west monsoon period.

SOME of the troubles which have to be faced by engineers in Egypt are described by Mr. J. B. Van Brussel in an article on mechanical irrigation plants in the *Engineering Magazine* for February. Part of the Nile irrigation station at Wadi Kôm-Ombo consists of a steel canal 5200 feet in length and nearly semicircular in section, 20 feet diameter, and about 12 feet deep. The canal is used for conveying water from the service reservoir and distributing it to earth canals, or culverts, and is made up of seventeen sections, each about 310 feet long and constructed of riveted steel plates 6 millimetres thick. The sections are connected by expansion joints, and have a fall of level of 1 centimetre per 310 feet. Great difficulty was experienced in preserving the level while building, owing to the action of the wind passing through spaces where the dry foundation sand had been removed for riveting, thus causing the sand to drift and the wood cradles to sink. Often a whole section would sink several inches in a night. During the construction difficulty was also experienced due to unequal expansion. According to the side of the canal on which the sun was shining more strongly, the end of a section would move out of the centre line to one side or the other to the extent of as much as 4 inches. This movement stopped when the earth was banked up round the steel structural work, and the water began to flow through the canal.

THE January number of *Ion* contains a translation of the second memoir of the radium commission of the Academy of Sciences of Vienna. It deals with the evolution of heat by radium, and for it Drs. E. von Schweidler and V. F. Hess are responsible. Experimenting with more than a gram of radium-barium chloride enclosed in a glass tube a millimetre thick, surrounded by a copper vessel 5 millimetres thick, they have found that the heat generated by 1 gram of pure radium in these circumstances is 118 gram-degrees per hour. *Ion*, by a curious misprint, omits to give its readers this number.

AN examination of the whole of the material at present available on the variation of the refractive indices of mixtures of liquids with their composition has led Dr. V. F. Hess, of the University of Vienna, to formulate, in a paper which appears in the July, 1908, number of the *Sitzungsberichte* of the Academy of Vienna, a simple law for the refraction constant of a mixture. If the excess of the observed density of a mixture over that calculated from the densities of the constituents be divided by the observed density, and if the corresponding quotient for the refraction constants be found, Dr. Hess shows that if it is assumed that the two quotients for each mixture are proportional to each other, the calculated values of the refraction constants may, by a proper choice of the factor of proportion, be made to agree very closely with observation. The factor differs in value for each pair of liquids, changes a little with change of temperature, but is practically the same for all rays of the spectrum. Any one of the three refraction constants at present in use may be used in the calculations.

THE moving-coil galvanometer is now used so extensively on account of its insensibility to outside magnetic disturbances that Dr. M. Reinganum's article in the *Physikalische Zeitschrift* for February 1, describing two methods of making the instrument suitable for measuring smaller currents than it has been capable of measuring previously, will be welcomed by many of our readers. In the first method about 6 centimetres of soft iron wire, 0·33 millimetre diameter, is attached to the top of the coil outside the strongest part of the magnetic field, and at right angles to the lines of the field. In the second method a similar piece of magnetised steel wire is attached to the coil parallel to the field, but with its poles reversed. In each case the sensitiveness of the instrument is greatly increased, and in one case described by the author, with the steel wire, it was raised to ten times its original value without the deflections ceasing to be proportional to the current passing through the coil.

IN Reprint No. 101 from the Bulletin of the Bureau of Standards, v., 2 (Washington: Government Printing Office, 1908), Mr. Louis Cohen discusses the influence of terminal apparatus on telephonic transmission. It is pointed out that when a telephonic wave reaches the receiving instrument part of it is reflected, and that the proportion of the reflected and absorbed waves is a function of the frequency. Thus every harmonic will be affected differently, and a certain amount of distortion will be produced. The subject is eminently suited for the methods of mathematical analysis which the author applies. The outcome of the discussion is that in short-distance transmission the introduction of a condenser into the circuit will improve the transmission. This is the conclusion derived from an application to a cable 30 km. long. For long-distance transmission, taking as an example a length of 300 km., the author finds that the condenser has little effect.

MESSRS. MACMILLAN AND CO., LTD., have published the "Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College for the years 1899–1908." The papers have been edited by Messrs. E. J. Brooksmith and R. M. Milne, who have also provided answers. The price of the volume is 6*s*.

MESSRS. CROSBY LOCKWOOD AND SON have just published the second edition of Dr. J. Erskine-Murray's "Handbook of Wireless Telegraphy." The original work was reviewed in NATURE of October 3, 1907 (vol. lxxvi., p. 563). About fifty pages of new matter have been added, and the whole text has been revised in the light of present knowledge of the subject.

MESSRS. H. W. COX AND CO. have issued a new catalogue of electromedical apparatus, which contains, in addition to the descriptions of the apparatus, short sketches of the theories of their action, and instructions how best to set them up. It should prove of exceptional value to medical practitioners who have not had the advantage of a practical training in the manipulation of physical apparatus.

WE have received from Washington a copy of the report of the Librarian of Congress and of the report of the superintendent of the library buildings and grounds for the fiscal year ending June 30, 1908. Like all American reports, it is of a detailed and exhaustive character, and provides information as to accessions, expenditure, new arrangements, and other matters of particular importance to librarians. It is of interest to note that, in addition to the Library of Congress, with its million and a half books —to say nothing of manuscripts, prints, maps, and charts —there are above a score of libraries maintained by the Federal Government at Washington. Among these may be mentioned those of the Department of Agriculture with 60,000 volumes, the Bureau of Education with 82,000, the Geological Survey with 80,000, the Patent Office with 80,500, and the National Museum with 20,000. Some of the special collections, like that of the U.S. Geological Survey, are unique in character, so it is easy to see that the American student is very fortunate in his facilities for reference to standard authorities and original sources.

OUR ASTRONOMICAL COLUMN.

THE SPECTRA OF VARIOUS NEBULÆ. The spectra of several nebulæ, as photographed at Heidelberg with the Waltz reflector, are briefly described by Prof. Wolf in No. 4305 of the *Astronomische Nachrichten* (p. 151, February 16).

Prof. Wolf states that the planetary nebula N.G.C. 6210=B.D.+24°.3048 is so bright that he is able to photograph the ten lines of its spectrum with only a brief exposure. These include six of the chief lines, at λλ 501 (i.), 434 (iii.), 410 (iv.), 397 (v.), 387 (vi.), and 373 (vii.), lines at λλ 412, 447, and 496, and Hβ; the second nebula line, at λ 469, is not recorded, and Hγ is clearly double.

The Ring nebula in Lyra shows the seven chief lines, Hβ, and the line at λ 496, but no spectrum of the central star is registered. Exposures without the spectrograph give an image of the ring in twenty seconds, but give no trace of the star, thus showing that the latter is less active, photometrically, than the ring itself. Using Wratten and Wainwright's "panchromatic" plates, Prof. Wolf also got the C line of hydrogen registered, and found it to be as bright as the other hydrogen lines. By using an open slit, annular images showing the monochromatic forms and sizes of the nebula were obtained; the ring at λ 469 was found to be the smallest, whilst that at λ 373 is the largest.

Long exposures on the cluster of nebulæ near the galactic pole (12h. 53m., +28°.6) showed continuous spectra with maxima, but the condensations are too weak to measure. The spectrum of N.G.C. 6960, HV 15 Cygni, is purely gaseous, the brightest line being that at λ 373, followed by λ 434 (Hγ), and traces of other lines. N.G.C. 6992, HV 14 Cygni, shows the same spectrum with the addition of Hβ. The Milky Way nebula, N.G.C. 2023, again shows the lines at λλ 373, 434, and 486, but the line λ 373 is abnormally bright, and there is a suspicion of an additional line at about λ 345.

THE PROPOSED PROGRAMME OF WORK FOR THE REYNOLDS REFLECTOR AT HELWAN, EGYPT.—From a note in No. 27, vol. ii., of the *Cairo Scientific Journal* (p. 417, December, 1908), we learn that the Reynolds reflector at the Helwan Observatory is to be used, primarily, for the photography of nebulæ lying between the equator and 40° south declination.

Mr. Knox Shaw shows that the instrument, owing to its comparatively short focal length, is unfitted for work on the sun and moon, whilst the absence of a large finder renders the photography of faint satellites impracticable; the ratio of the focal length to the aperture (30 inches) is only 4·5.

In the proposed zone there are between two and three thousand known nebulæ, of which the great majority have as yet only been observed visually, and, according to Keeler's estimate of their distribution, there should, in such a zone, be some 40,000; it therefore appears that the Reynolds reflector is provided with a very useful programme for a lengthy period.

OBSERVATIONS OF COMET TEMPEL$_3$-SWIFT.—In No. 4306 of the *Astronomische Nachrichten* (p. 159, February 18) Prof. Barnard records his observations of the periodic comet, Tempel$_3$-Swift (1908*d*), during its recent reappearance. Observations were made on four days in December, 1908, and the comet was found to be a small faint body of less than the sixteenth magnitude.

A new double star and two new nebulæ were discovered during the observation of the comet, and Prof. Barnard found that the star B.D.+43°.53 is one of the finest crimson stars in the heavens; on December 20, 1908, he recorded it as an exquisite object as seen in the 40-inch refractor.

THE LEVELS OF SUN-SPOTS.—From Mr. Dodwell, of the Observatory, Adelaide, we have received a stereogram which confirms Dr. Krebs's observation of the different levels of sun-spots, referred to in this column for August 27, 1908 (No. 2026, vol. lxxviii., p. 402).

The two photographs from which the stereogram was prepared were taken by Mr. A. W. Dobbie, of Adelaide, during the solar eclipse of 1905, and the two groups of spots then visible on the solar disc distinctly appear to be at different levels. Mr. Dobbie used an 18-inch Newtonian reflector of 13 feet focal length, made by himself, and stopped down to an aperture of 4·5 inches. The exposures given were of about 1/100oth of a second duration, and the interval between the two was about 2½ hours.

A NEW "CAVE-NEBULA" IN CEPHEUS.—On a plate taken by him with the Bruce telescope at Heidelberg, on October 21, 1908, Dr. Kopff discovered an interesting nebula in the constellation Cepheus.

Later photographs taken by Prof. Wolf, with the Waltz reflector, show this object to be a good example of the singular phenomenon of cave-formation amongst Milky Way stars. The star B.D.+69°.1231 is involved in the nebula, which is situated at the southern extremity of a long, starless space covered with intricate patches of nebulous matter and dark areas, and traversed by a bridge of stars, from east to west, at about 22h. 10m., +70° 0′. The position (1855·0) of the B.D. star is α=22h. 10m. 1s., δ=+69° 31′·7.

A reproduction of the region showing this interesting object accompanies Prof. Wolf's paper describing it in No. 2, vol. lxix., of the Monthly Notices (R.A.S.).

THE RECENT MAGNITUDE OF NOVA PERSEI.—In No. 4303 of the *Astronomische Nachrichten* Prof. Nijland publishes the results of a series of magnitude observations of Nova Persei (No. 2) made at the Utrecht Observatory between July, 1904, and April, 1908. The apparent variations, if real, are unimportant and irregular, the four yearly values being 10·63, 10·53, 10·58, and 10·59, mean 10·58; on Father Hagen's scale this magnitude lies half-way between his stars 42 and 49.

DOUBLE-STAR MEASURES.—Nos. 4301 and 4302 of the *Astronomische Nachrichten* are devoted, to the extent of eighteen three-column pages, to the results of recent micrometer measures of double stars, made by Prof. Burnham with the 40-inch refractor of the Yerkes Observatory. The measures form part of the observer's general programme of observing neglected doubles, to investigate proper motions, and to provide material which may in future have special value in any discussion of the pairs given in the general catalogue.

A series of notes, dealing respectively with the individual systems, is also given, and will undoubtedly prove useful in any subsequent discussions.

SCIENTIFIC RESEARCH AND THE CARNEGIE TRUST.

THE seventh annual report, that for the year 1907–8, of the executive committee to the trustees of the Carnegie Trust for the Universities of Scotland, was submitted at a meeting held in London on February 24. The report contains a review of the activities of the trust during the seven years of its existence. In the first place, the committee directs special attention to the scheme of endowment of post-graduate study and research, which completed its first lustrum on September 30, 1908. The committee submitted the results of the scheme over the five years to independent authorities for examination and report. For this purpose the services were obtained, in the physical and chemical sciences, of Dr. J. J. Dobbie, director of the Royal Scottish Museum, and formerly professor of chemistry in the University College of North Wales; in the biological and medical sciences, of Dr. J. Ritchie, superintendent of the Royal College of Physicians' Laboratory, and formerly professor of pathology in the University of Oxford; and in the historical, economic, and linguistic sciences, of Prof. P. Hume Brown, Historiographer-Royal for Scotland.

The assistance offered by the scheme was of three kinds —scholarships, fellowships, and grants—in order, so far as possible, to reach all classes of workers. Selection was made, not by competitive examination, but for fellowships on the merits of original work already published, and for scholarships on the evidence of experts regarding the applicant's special fitness for the work proposed. No fixed number of foundations, nor even a definite total sum, was assigned to any one year. The aim of the scheme was, within the limits of the trust deed, to discover and supply the demand for assistance in higher study and research throughout Scotland. The actual expenditure upon the scheme for the first quinquennial period was 27,755*l*.

Two points in connection with the reports of the experts referred to above are mentioned. The first is that the reports must be taken as representing only part of the output of the universities of Scotland in higher study and research; for in many departments, and not merely in those outside the scope of the trust, much independent work of the kind is being done. The second is that in providing the scheme with so many able workers, as well as in affording laboratory accommodation and supervision, the universities deserve much of the credit due to its success.

In summarising the grants to universities and extra-mural colleges, the report states that, of the total grants during the past six years, amounting to 246,374*l*., 23,000*l*. has been allocated to libraries, 131,644*l*. to buildings and permanent equipment, and 91,730*l*. to teaching. In this allocation the committee was guided by the special needs of each institution as set forth by its governing body. It is gratifying to find, in the statements received from the universities and other institutions regarding their claims under the second quinquennial distribution, their general recognition of the great benefits that have accrued.

The second quinquennial scheme of distribution, besides making contributions of 65,250*l*. to buildings and permanent equipment and 20,500*l*. to libraries, will at the close of the period of five years have increased the resources of teaching in the four university centres by permanent endowments amounting to 87,500*l*., and have afforded during the five years an annual income of about 4150*l*. to meet ordinary expenditure.

During the period of seven academic years in which the scheme of payment of class fees has been in operation, the individual students whose fees have been paid by the trust number 8263, and the fees paid reach the total of 298,687*l*. Fifty-five beneficiaries under the scheme have made voluntary repayment of fees paid on their behalf, amounting in all to 881*l*.

With regard to school education of applicants, the committee has been able since the year 1907–8 to demand of all applicants a standard equivalent to that of the universities arts and science preliminary examination, or of the leaving certificate of the Scotch Education Department.

The expenditure for 1907–8 upon the research scheme and upon the laboratory was respectively 6340*l*. and 2185*l*., towards the latter of which the Colleges of Physicians and of Surgeons have together contributed 950*l*. Under the head of grants to university centres a sum of 73,998*l*. 5*s*. 9*d*. was available for distribution during 1907–8. The statistics of the payment of class fees for the academic year 1907–8 give the total number of beneficiaries as 3269, the total amount of fees paid as 43,256*l*., and the average amount in fees paid per beneficiary as 13*l*. 4*s*. 8*d*., an increase as compared with the preceding academic year of 107, 2154*l*., 16*s*., and 4*s*. 8*d*. respectively.

In his report on the scheme of endowment of post-graduate study and research, Dr. J. J. Dobbie, dealing with the physical and chemical sciences, remarks that a careful examination of the papers relating to the work of the Carnegie fellows, scholars, and grantees in the mathematical and experimental sciences has confirmed and strengthened the conclusions expressed in the report of January 19, 1905, as to the satisfactory working of the scheme for the encouragement of post-graduate study and research. The high standard set in the appointment of the first fellows and scholars has been well maintained in subsequent appointments. With few exceptions, the beneficiaries have fully justified their selection by the trustees. They have carried out successfully a large amount of research work. During the past five years thirty-seven individuals have been appointed to fellowships or scholarships, and twenty-five, not including fellows, have received grants. The detailed numbers, excluding grantees, are:—mathematics, 2; physics, 8; engineering, 4; chemistry, 23. It is a noteworthy circumstance that the fellows and scholars in chemistry outnumber the total of all the other branches of the mathematical and physical sciences. This may, perhaps, be accounted for to some extent, but not altogether, by the fact that the comparatively fresh field of physical chemistry offers certain attractions to students who formerly would have devoted themselves to purely physical research. Some students are thus classed with the chemists, who might with equal reason be reckoned amongst the physicists.

The fellows and scholars have contributed together one hundred and seventeen, and the grantees twenty-two, papers to the scientific journals. The papers in every case embody the results of original investigations conducted by their authors, and in the aggregate contain a very large number of new observations, some of which have proved of real value in furthering the development of the branch of science to which they relate. Nearly all the papers of the beneficiaries have been published in the journals of one or other of the great societies. It is well known that since the inauguration of the trustees' scheme the output of experimental work by the Scottish universities has greatly increased. In chemistry alone, in the course of the last two years, the number of papers dated from the laboratories of the Scottish universities which have been published in the Journal of the Chemical Society is twice as great as the number appearing in the two years immediately preceding that in which the scheme came into operation; and a still more important result is to be found in the opportunity which the scheme has afforded for co-operation within our laboratories. Although Scotland has in the past produced many eminent investigators, they have, with a few notable exceptions, been solitary workers. It is only within the last few years that "schools" of research, such as have long been the strength of the scientific departments of the German universities, have come into existence there, and the encouragement which the Carnegie scheme has given to this movement is not the least of its claims upon the gratitude of the scientific world.

Dr. James Ritchie, in reporting on the biological and medical sciences, states that during the period under review eighteen fellows have been at work. Of the total number, ten had previous to election to fellowships been beneficiaries of the trust, either as scholars or grantees. The distribution of the fellowships as regards the different branches of science were as follows:—agriculture, two; zoology, two (including one in protozoology); anatomy, three (including one in embryology and one in anthropology); physiology, six (including one in experimental psychology); pathology, five (including one in neurology). Of those appointed to scholarships, numbering in all forty-

nine, eight have been promoted to fellowships. Of the others, eight resigned before the beginning of the academic year, and nine during the academic year in question. The departments of science in which the scholars proposed to work, or in which they have worked, are as follows, the numbers indicating the applicants in each branch:—geology, one; palæontology, one; botany, seven; agriculture, five; zoology, five; anatomy, two; embryology, two; physiology, three; pharmacology, two; pathology, eleven; surgery, two. The distribution of ninety-one grantees, according to their subjects, was as follows:—meteorology, one; geology, six; palæontology, two; botany, three; agriculture, four; zoology, ten; anatomy, seven; embryology, four; anthropology, one; physiology, sixteen; pharmacology, four; pathology, twenty-eight; therapeutics, five. The grantees fall into three groups:—(*a*) cases where grants have been made to persons holding responsible positions as heads of scientific departments or to assistants in such departments; (*b*) cases where grants have been made to persons in other positions, and who are engaged in research work in leisure time; (*c*) cases where grants have been made to young workers often in lieu of scholarships for which they have applied.

In concluding his report, Dr. Ritchie remarks that it is not difficult, in reading between the lines of the papers relating to the beneficiaries, to see that in very many cases the work which has been done would never have been undertaken unless the assistance of the trust had been given, and that in no corresponding period in the history of the universities of Scotland has so much research work of such uniformly high character been successfully carried on.

As regards historical, economic, and linguistic subjects, Dr. Hume Brown reports that, out of eighteen scholars and fellows, there are only four who have failed in greater or lesser degree to fulfil the conditions of the trust. What is noteworthy is that the work done has been original work, which really advances the various subjects undertaken by the beneficiaries. There appear to be three chief causes of the few failures that have occurred. Some candidates were recommended on the strength of their record of study in the universities, but it may happen that students who have distinguished themselves under the pressure of competition may show a lack of concentration when that pressure is removed. Such cases will occur, and can hardly be prevented. Another cause of failure is that the scholar had no clear conception of the work he undertook, with the result that time and labour were lost before he found his way to the essentials of his subject. The majority of the applicants for scholarships have had little or no previous experience in research, and it is important that they should be carefully supervised. The beneficiaries who have received grants are seventeen in all, of whom only one or two have proved more or less unsatisfactory.

At the annual meeting of the trustees on February 24 Lord Elgin moved the adoption of the report, Mr. Balfour seconded, and the motion was adopted unanimously.

In the course of his remarks, Mr. Balfour said:—This is a special occasion in the history of the trust. It is the first time that anything in the nature of a complete survey of the work that has been done under certain sections of the trust has been possible to us. It is the first time that the public can be really put in possession of information which will enable them to judge of the value of the great benefaction which the founder established for his countrymen and for the world. There is one department of the trust of which, since I am not a member of the executive, I may speak with a freedom of praise which would be quite impossible were any of the credit or any of the responsibility due to me. I refer to that portion of the work with which this great report is chiefly occupied—the portion of the work which consists in encouraging original research.

It is evident that this great object is partially ministered to by that portion of our endowment which is given to equipping libraries, laboratories, and providing our universities with all the modern appliances which seem ever more costly as the progress of science advances, and without which it is quite impossible for a modern university to do its proper work. But it is not on that portion of our labours on which I should like, specially at the moment, to congratulate Mr. Andrew Carnegie and the executive. It is rather upon the portion of the work which deals with the encouragement of those competent to carry on original work—an encouragement over and above that of merely supplying universities with the necessary equipment of books and apparatus. It is obvious that the task of selecting people who can do this work is very difficult and very delicate. It is surrounded with puzzling questions of administration, but the way it has been solved by the executive committee of the universities concerned, and the success which has attended their efforts, raises even the highest hopes of even the most optimistic and hopeful in connection with the movement. There is no greater waste in the world, and no more serious waste in the world, than waste of brains and intellect, of originality, and of scientific imagination, which may be used to further the knowledge of mankind of the history of the world, if men who are capable of carrying on investigations of this sort are given the opportunity of doing so. Competitive examinations are literally no test whatever of ability for original research. What is wanted is something much higher, much rarer, than the mere capacity for absorbing knowledge, and reproducing it rapidly when the time for examination comes round. What is required is some spark of that divine genius which shows itself in many ways, but which is, after all, a great element to which we must look for the progress of our race and the improvement of our civilisation.

What is it we want to do? We want to catch the man immediately after he has gone through his academic course, before he has become absorbed in professional life. At the moment when ideas spring most easily to the mind, when originality comes most naturally to the happily endowed individual, we want to catch him and turn him on to some inquiry which he is fully qualified to pursue with success. It is not an easy task to catch the man, and the number of men worth catching is not very large. The report speaks of a certain number of failures; there are not many among those who have been selected. It is amazing that the number is not much larger. No intuition will ever enable us to discover whether the man has anything beyond the ambition to do good work in original research. We have only to look at the reports of the experts who have dealt with the papers to consider the growth in the number of original papers accepted by scientific magazines which have issued from Scotland to see how much has been done to further this great cause of original research. We may divide the persons who are competent to carry on original research roughly into two classes, those who have the gift and ambition, but not one of those rare and overmastering ambitions which forces a man into this particular career for all his life. We have to catch them before they get absorbed in the necessary occupations of life and extract from them all we can in the way of invention and originality. Then there is a rare and higher class, those who seem born for research, to whom the penetration into the secrets of nature or into the secrets of history is an absorbing and overmastering passion, from which they will not be diverted or arrested except by absolute overmastering necessity of earning their daily bread and supporting themselves and their families. To these men it is all important, not for the sake of the men, but for the sake of the community, that they should have a chance of devoting their talents—rare talents—to that great work for which God undoubtedly intended them.

Work of the kind being done will never be able to be estimated by tables of statistics or measurement of output, but, in spite of that, will count, and count largely, among the affairs to which we shall owe the progress of knowledge, of invention, and of civilisation. Mr. Carnegie has, by this endowment of research, done a work which not only adds lustre to the history of his native country, but also has no provincial or national aspect about it, and will add to that stock of knowledge and invention which, when once made, is the common heritage of civilised mankind. In so doing Mr. Carnegie deserves not merely the thanks of those to whom he has entrusted the administration of his magnificent benefaction, but the thanks of the whole civilised world.

THE FUNCTIONS OF TECHNICAL COLLEGES.[1]

IN glancing over the early history of mechanics' institutes in this country, it is not at all clear that their founders believed that the maintenance of the position of Britain as an industrial nation was likely to depend in any direct way on the more scientific education of the working classes. The industrial position of the nation was still unchallenged, British labour was still as efficient as that of any other country, the organisers of industry were second to none in shrewdness and enterprise, and the rising suns of America and Germany were still below the industrial horizon. While the exact date at which these orbs arose may be uncertain, there can be no doubt that early in the last quarter of the nineteenth century they were already well above the horizon, and were beginning to cast sharp shadows across the industrial fields of Great Britain. Long before these signs had become obvious to the commercial and industrial classes, a number of far-seeing men, some of them industrial leaders, but the majority men of science or education, had raised the cry of more extended and popular education in science. Thanks to their advocacy this policy of reform began to make itself felt, and before the final decades of the century were spent the modern technical education movement was well under way.

Even if I were sufficiently informed to sketch for you the history of this movement, it would be superfluous for me to do so, as you are already familiar with the various stages in its development. My purpose in recalling the past was rather to help me to present to you the situation to-day, as it appears to me, not as a professed educationist, but as one who has for more than a generation been closely associated with industry and with the application of scientific methods to its development. I am fully conscious that my own views on the subject of technical education are still in process of crystallisation, and I cannot do more than ask you to accept me among your number as a student who desires to cooperate with you in advancing the great cause you have at heart.

These yearly gatherings may be regarded as halting places on our journey, from which we may look backwards over the various routes along which we have been travelling, and forwards into the country which still stretches ahead. The particular route on which it has been my lot to travel has not been wanting in variety and interest for the traveller, but as I have not yet reached the age at which my personal reminiscences could have any claim on your indulgent attention, I only refer to the journey in these general terms, and mainly because it has been made over one of the less frequented routes. As some of the hilly parts of the route happened by good fortune to be traversed in stimulating company and under favourable conditions of the atmosphere, the views which were then absorbed have left many vivid impressions, some of which have no doubt influenced me in my choice of a subject on which to address you.

It appears to me that the time has arrived when we may profitably review the position of the technical institutions in their more direct relations to the industries of the country. If we are possessed by the belief that the industrial future of the nation must largely depend on the spread of education in science and in the application of its laws to the affairs of daily life, then we cannot escape from the conclusion that it is our particular duty to see to it that we are taking a leading part in this vitally important work. This is the task which has been laid upon us by our founders and supporters, public and private. It is also the task to which we have committed ourselves from the moment when we began to enrol students in our classes. These students have come to us in the belief that we in our superior wisdom can guide and train them for the more assured places in the world of industry, so that our obligations to them also compel us to associate ourselves more and more closely with the industrial interests. It is hardly possible to over-estimate the importance of the task we have undertaken, and the more we appreciate its magnitude the more likely shall we be to cultivate only the broadest and most fully informed views of the lines on which we may hope to discharge it worthily.

While we must realise that this is essentially the task which is now laid upon the technical institutions, and that it devolves upon these bodies to take the lead in stating the problems which are involved and in working towards their solution, we none the less gratefully recognise the pioneer work of the universities in the same fields. It behoves us, therefore, to walk hand in hand with those universities which have established within their own boundaries faculties of applied science, and to avail ourselves of their experience, not only in this special department, but also in other fields of professional training. For the universities, however, this problem is only one among the many with which they are called upon to deal, while for the technical institutions it is the central problem. The very singleness of our aim, therefore, ought to give a force and concentration to our efforts which should go far to ensure success of a kind which has never before been attained.

The training of men for the practice of the learned professions has always been largely in the hands of the universities, and one of the principles which has been evolved in the organisation of this training is of the deepest interest for us, as it has an important bearing on the work we are called upon to perform. This principle is that the final judgment as to the courses of study and preparation should rest mainly with practising members of the professions. I think I am right in saying that in the faculties of law, of medicine, and of theology, this has been recognised, and that throughout their courses of study and preparation the students are brought into contact with practising members of the profession for which they are qualifying. They have thus the opportunity of realising the practical bearing of their intellectual studies on the work of their profession, and the intellectual atmosphere around them is that peculiar to their profession. One result of this is that when the graduates in these faculties leave the university they already possess the instincts of their profession, and are proud to be classed among its members. They may be, and probably are, very inexperienced members, but the fact remains that they have been professionally trained. This means that the knowledge they have acquired has already been to some extent correlated to the work which they are expected to perform. They have been trained to state the practical problems of their profession in a scientific way, and to look for their solution through the methods of accurate and intelligent observation and reasoning.

This principle is equally recognised outside the universities in the training required for the newer professions. The professional bodies which regulate the admission to their membership of civil engineers, architects, accountants, and analytical chemists, all require that the education of the candidates shall be of a definitely professional character, and it is always supervised by practising members of the particular profession.

If the training in our institutions is to be modelled on the lines of the best professional standards, we shall have to secure the active cooperation of representative men from those industries for which we propose to train our students. With the help of these representatives we must organise courses of instruction, practical as well as theoretical. We must give to the practical side the same kind of reality as is found in the clinical teaching of medical students, and it must be made compulsory for all who desire to obtain the full diploma of the college. It ought, therefore, to be supervised by a joint committee of the board of studies and the representatives of the industries. If the colleges, with the cooperation of industrial representatives who are themselves employers, can in this way organise and supervise the practical side of their training, the education of the engineer, the electrician, and the chemist will be rendered homogeneous from beginning to end, and the diploma will then be as definite a guarantee of complete professional training as the medical degree now is. In both cases the experience which only results from practice has still to be won, but the professional training will enable its possessor to begin to make his experience through his own practice.

[1] Address delivered at the annual meeting of the Association of Technical Institutions on February 5 by Dr. George T. Beilby, F.R.S., president of the association.

You will perhaps say that this is a counsel of perfection. Well, even if it be so, I think it is worth while occasionally to indulge in such counsels. I will therefore ask you to follow me rather more closely into the question. Let us first consider what is the present position as regards the training of the class of students whom we are supposed to understand best, the engineers. In this matter our colleges have been satisfied to follow on the lines laid down by those universities which confer a degree in engineering science. This degree, like the diploma of our colleges, is granted without any reference to office or workshop training. Under the "Sandwich system" time is given for the students who choose to do so to obtain a certain amount of experience in outside offices or workshops during the intervals between the university terms, but there is no direct supervision of this work, it is not even compulsory, and any student with the necessary intellectual capacity can take his degree quite as well without as with it. Though the universities and colleges take no official cognisance of the fact, yet the students are given to understand that if they desire to qualify themselves for responsible posts in the engineering world they must serve either a full or a modified term of apprenticeship in some recognised office or workshop before, during, or after their college course. They must be prepared, therefore, to devote from six to eight years to obtaining the full training required for their profession. Even the longer of these periods is not too long, but we must admit that it is a fairly large slice out of the life of a man, so that it behoves us to make sure that it is used to the best advantage. If we analyse the total period of eight years, or ninety-six months, we shall find that from twenty to thirty months are spent in close study and examination work, eight to ten months in holidays, fifty-six to sixty-eight months in the workshop or office. I find it difficult to believe that this is an ideal distribution of the time; at any rate, it appears to me that we ought to be able to put ourselves into a position from which we may be free to discuss it in its various aspects *and to modify it in an authoritative way if it seems right that we should do so.* Under present conditions these young men come to us and in effect say, "We want your degree or diploma, but as we shall also have to spend a number of years as apprentices we cannot afford to give you more than three years, therefore be good enough to do the best you can for us in that time," and we certainly try to do our best in the circumstances; but the circumstances are rather unfortunate, for do we not too often find ourselves helpless to contend against the "examination bogey" which obtrudes itself at every turn? So much book and lecture work has to be overtaken in three short years that if we attempt to develop the intelligence of the students in any directions which do not lie directly in the line of the degree, they are at once unsympathetic or even obstructive. The students cannot afford to give themselves any time to develop their own thinking and reasoning powers, and yet the time spent at college or university ought to be the great intellectual opportunity of their lives. Not once, but many times, have I been shocked by the absolutely unintellectual outlook of the bright and apparently capable young men who pass through our colleges. Now it appears to me that if these young men could come to us and say, "We know that we must give seven or eight years to preparing for our life's work, will you undertake to organise and supervise our training, practical as well as theoretical, for the whole period, and will you then give us a degree or diploma which will be a real mark of our professional training and fitness?" we could accept the larger responsibility with lighter hearts and with a hopefulness which we have no right to feel under present conditions.

Our larger institutions are in a unique position to deal with this matter in a courageous manner, for they hold a mandate directly from the people who are most deeply concerned in it. To put it at once on its broadest ground, the nation has a right to expect this from us. Some of the universities have given us a noble lead in our earlier development, but I am bold enough to think that we have outgrown that lead, and the sooner we recognise that fact the better it will be for those who are depending on us. Not only is public opinion on our side, but industrial opinion is being rapidly permeated with more advanced views on the mutual relations of science and industry. The most practical result for us is that industrial leaders and manufacturers are beginning to give us their active sympathy and cooperation. This appears to me to be the real key to the situation.

Speaking for the college with which I am associated, I can say that this cooperation is an accomplished fact. It is now some years since the governors instituted a regular system of committees of management for the different departments of work. These committees are empowered to deal, not only with the purely business matters which arise in their departments, but also with questions of educational policy, and they act as the intermediaries between the board of studies and the governors. The board of governors itself is fairly representative of the leading industries of the district, but the departmental committees are made more directly representative by co-opting as members the heads of the leading manufacturing firms and professional men of acknowledged standing and reputation. The industrial leaders are now within the inner circle in the management, and can not only assure themselves as to the nature and quality of the educational work which is being done, but are able to exert a real influence upon it. For the students of the college the cooperation of the industrial leaders has a double advantage, for not only have they the assurance that their education is being conducted on lines approved by practical men, but they know also that these men are the representatives of the class which holds the key to the principal openings for their future employment.

By securing the cooperation of the industrial leaders we have taken an important step towards securing for our students the full professional training which seems to me so desirable. We have also made a beginning in developing an atmosphere of practicality in the college; but all the advantages of this union are not on the side of the college. Speaking as myself an industrial man, I can say that we also stand in much need of the kind of education which our close association with this work is admirably adapted to give us. Many of us have still no clearly defined ideas as to the way in which more scientific methods and more highly trained experts can be of advantage to our particular industries. Many who have the will to avail themselves of these helps are at a loss to understand in what way the new wine of modern technological training can be introduced into the old bottles of industrial tradition without disastrous consequences for both. If it is frankly admitted that both sides in the combination have much to learn, first from each other and later from their joint experiences, I am exceedingly hopeful that the way will be opened up for a very real advance in the scientific organisation of industry. As regards our trade classes, this principle of cooperation had to be admitted very early in the day. It was obvious that apprentices and learners could only be trained in craftsmanship by teachers who were themselves craftsmen. For the management of these departments committees have been formed which consist mainly of master craftsmen and employers. The trade employers have responded to our call, for they have found in these trade classes the modern substitute for, or supplement to, the old system of apprenticeship. We have in this instance an almost ideal fusion of the practical and theoretical sides of the training. The student passes so freely from workshop to college and from college to workshop that there need be no sharp line of demarcation between the two methods of obtaining knowledge. The soundness and practicality of his training in handicraft is assured, while on this foundation of craftsmanship we can build an equally secure superstructure of intellectual training suited to his needs. We can teach him to lay off his work with scientific method, and with a sound knowledge of the properties of the materials, and to conduct the various operations with a knowledge of the natural laws on which these operations depend.

The consideration of the system in force in the trade classes brings out more forcibly the weakness on the practical side of the training of engineers and chemists. The atmosphere of practicality which is so essential a feature in the one case is conspicuously wanting in the other; but

this consideration may well encourage us to hope that the combined system which works so admirably in the trade classes may lend itself in a modified form to the solution of the more complex problem of the practical training of the engineer and chemist.

The problem is certainly more complex, but from the industrial point of view it is really not more serious than that which has already been faced by the handicraft trades. If the manufacturers and industrial leaders can be brought to realise, as the master craftsmen have done, that it is our central purpose to educate our students of all classes in the best possible way for their future work in industry, then I feel assured that we shall gradually secure more and more of their active help and cooperation. Without this help it would obviously be impossible for us to organise the workshop or other practical training of our students, but with it the difficulties may easily be surmounted.

If we are to undertake the organisation of the practical part of the training of our students, the cooperation of the employers will be necessary (1) to keep us supplied with a sufficient number of posts for temporary apprentices or learners in their works, and (2) to enable us to keep some kind of supervision over the students during their training. Probably a visiting inspector would be required, whose duty it would be to keep in touch with the managers of the works in which the apprentices are placed. This officer would be invaluable in making all detailed arrangements between the managers and the college, and in arranging for the distribution and re-distribution of apprentices among the various works.

It is well to remember that in seeking for opportunities for practical training we are not necessarily restricted to engineering works. In connection with the various municipal enterprises, electric lighting and power works, gas, water, and sewage works, employment may be found if the heads of these departments can be induced to take the necessary trouble. We shall return to this question in considering the position as regards students who are preparing to take their place in chemical industry.

While the colleges would be deeply indebted to the manufacturers who would cooperate with them in this matter, we need not neglect to represent to these gentlemen that the advantages would not all be on one side. By the cooperation the whole system of the apprenticeship of educated young men would be put on a more businesslike footing, "slackers" and "loafers" would be quickly found out and dealt with or dismissed, and intelligent hard work would be encouraged. I am not blind to the fact that there will be difficulties to be got over and asperities to be smoothed before the arrangement can be got into thorough working order, but none of these need be formidable, and we must expect to encounter little troubles in making any important change of practice.

The training of chemists for industry is a subject which has been much discussed again during the past year. Early in 1908 a subcommittee of the governing body of the newly created Imperial College of Science and Technology made a report on the subject to that body, but as that report has not been published I shall refrain from making any remarks upon it. Some of the provincial sections of the Society of Chemical Industry have also organised discussions on the subject. The first of these took place at the University of Birmingham.

At the British Association meeting in Dublin, Prof. Stanley Kipping made this the subject of his presidential address to the chemistry section. This widespread discussion shows at least that there is a healthy interest in the subject in quite a number of quarters. It occurred to me that the best way to introduce the subject on this occasion would be by a brief narrative of the action taken by the Institute of Chemistry some three or four years ago. The institute is a professional body, and it exacts a very high standard of attainment both in science and in the professional application of chemistry. Its examinations are largely practical, and any chemist who has attained to the associateship must be recognised as fully competent to take charge of all the ordinary chemical work of the laboratory. The full qualification of fellowship can only be attained after the associate has produced satisfactory evidence that he has been in successful practice as a professional or industrial chemist for five years subsequent to his admission to the associateship. The fellowship is therefore a direct guarantee of professional competency.

Some years ago the council of the institute formulated a supplementary scheme for the granting to its associates and fellows a further certificate in chemical technology. This scheme was only formulated after an exhaustive inquiry had been made, more especially as to the views of those chemical manufacturers who were themselves chemists. A practically unanimous opinion was expressed by these gentlemen that an ordinary laboratory training, even of the very thorough kind exacted by the institute, was not of itself a sufficient preparation for those who intended to make a place for themselves in chemical industry. In proceeding to formulate a scheme, the committee did me the honour of taking as their starting point a syllabus of chemical engineering which had been laid before the Society of Chemical Industry by me while I was its president in 1899. This scheme was greatly improved under the free criticism and discussion to which it was subjected by the able and practical men outside as well as inside the committee, and the syllabus which now forms part of the regulations of the institute ought to be regarded by our colleges and universities as a very valuable and authoritative pronouncement on the nature and scope of the study of chemical technology. As this subject had previously been either ignored or hopelessly misunderstood by the great majority of chemical professors and teachers, I think we must agree that the institute has earned the gratitude of all technical institutions by having placed on record this clear and compact synopsis of the subject. I am glad to have this opportunity of directing the attention of the heads of our technical colleges to this matter, and to suggest that those who are sending up students for the associateship of the institute should encourage them to take in addition the supplementary certificate in chemical technology.

During the formulation of this scheme there was considerable discussion on the question of practical works' training for students of chemical technology. This is a question on which there has often been misunderstanding. It has too readily been assumed that the chemical manufacturer who declines to throw open his works to students on the same lines as the mechanical engineer does is necessarily narrow-minded and obstructive. He is told from time to time by various learned persons that his supposed secret operations are a mere delusion, which would at once be exploded and superseded by something infinitely better if he would throw his works and process open to the criticism of the bright young graduates from our universities, yet he obstinately refuses to unlock his doors. I cannot plead guilty to any lukewarmness where the application of science to industry is concerned, but I must confess that I have considerable sympathy with the point of view of the much-abused manufacturer. If he happens to be using a process the conditions of which have been worked out by himself and his staff at much expenditure of time and money, is it at all surprising that he should regard this experience as one of his most valuable assets? Yet, strangely enough, his rights over this asset are only protected by British law if he is in the fortunate position of being able to secure a patent and maintain it against all comers; but in very many cases the prospects of being able to obtain or to maintain a patent are so problematical that he does not care to risk everything upon them, especially as the publication of a patent at once informs his rivals exactly what he is doing. In Germany, on the other hand, though the protection of this kind of intangible property is far from complete, cases of piracy by employees or others can be dealt with under criminal law, and the employer is thus placed in a much stronger position to protect his property.

I quite concede that there are many chemical works which might be thrown open to expert inspection because in their operations there is nothing special to be divulged, and in works of this description there is no intrinsic reason why student apprentices should not be admitted. But the habit of secrecy has become instinctive with the chemical manufacturer, for he is well aware that, though at one time he may have nothing to lose by publicity, yet in the

quick changes which occur in this industry he may any day find himself developing the kind of experience which finally becomes a real asset.

From the chemical manufacturer I fear there is not much to be hoped for in the provision of practical experience for our students, but fortunately there is much valuable experience for the young chemist to be obtained outside the chemical works. For him, as for the young engineer, the various departments of municipal enterprise ought to be made available. There is no finer school for the chemical technologist than the gas works which are to be found in every city. In these works the problems of fuel combustion and utilisation can be practically studied, and, in addition, destructive distillation, the handling and purification of gases, and the recovery and separation of by-products. The gas industry is still overflowing with interesting problems, and at the present time various revolutionary changes are looming ahead at no great distance. The gas manager who does not wish to be left behind in the race would do well to organise an experimental department, and to call to his assistance a staff of intelligent young men from our colleges. It may safely be said that there are very few chemical works which could afford so excellent a training ground for the chemist as the gas works might supply.

In what has gone before it cannot be said that the importance of the practical and professional sides of our educational functions has been minimised; I may therefore without fear of misunderstanding on this point seek to spend the short time which remains in putting before you certain views on the place which pioneer work in science and technology may occupy in our colleges.

It has been seriously suggested in certain quarters that the technical colleges should limit their functions to the training of students and craftsmen in the more obviously utilitarian applications of science, and should leave to the universities the cultivation of the higher developments of science. I think you will agree with me that this suggestion is altogether wrong. It is based on a most inadequate conception of what the mutual relations of science and industry ought to be. The heavy emphasis which I have laid on the practical and professional aspects of our work was designed to prepare the way for an equally strong insistence on the still higher functions which are involved in our intimate relations with scientific industry. Our purpose may be single, but it cannot be narrow and restricted, for in its final expression it involves nothing less than this, that our colleges must become, not only centres of light and leading, but also makers of new knowledge. I have spoken of the necessity for the creation in our colleges of an atmosphere of practicality, but we must now, in addition to this, consider the creation of a yet rarer atmosphere of intellectual enterprise and inquiry. These two atmospheres are not incompatible; on the contrary, they ought to stand to each other as complement and supplement in the circle of our educational functions.

In the large number of students who are passing through our hands we have at our disposal an almost ideal gathering ground for the brightest and most intelligent young men from the middle and industrial classes. During their training we have the opportunity of subjecting them to a sifting process, by which they may be broadly separated into classes according to their different kinds and degrees of ability. During this process of sifting it would be surprising if we did not find a few men who are capable of developing into enthusiastic pioneers, a proportion of whom ought ultimately to find their way to the front as real leaders in science and industry. Clearly it is our duty to provide for these men an environment in which they may breathe the vitalising air of intellectual inquiry and enterprise. If we turn this duty round to its other side, we shall see that it is one and the same as our duty to industry, and therefore to the community, for every man whom we can find and inspire in this way will become a substantial asset to the nation as well as to industry.

I do not put forward the plea that research is a necessary and desirable element in the training of *all* students, for I am still unconvinced on this point. Indeed, I am under the impression that many of the less successful students and graduates in science whom I have met have been seriously injured through having been encouraged in the idea that the cultivation of original research is the duty of every student of science. The real pioneering work will never be done by mediocre men. My claim for the recognition and cultivation of pioneering ability is not made in the interest of students at large, but for the sake of the men of exceptional capacity in this respect.

When we turn to the relations of our professors and teaching staff to this question we are faced by considerations which compel us to look very closely into our whole scheme of work in its true proportions and perspective. As we have seen, the duty which bulks most largely is that of providing an adequate technical or professional training for a large number of average young men. These large numbers cannot be adequately dealt with unless the teaching is organised and carried out on the most businesslike lines. This practical side of the question naturally bulks largely in the minds of the heads of our colleges, and we need not, therefore, be surprised that one of the qualities in the teachers which is most appreciated is the capacity for businesslike organisation.

It is fortunate that the combination of these businesslike qualities with high attainments in science is not more rare than it is, so that in our colleges we do find brilliant examples of this combination. Where this is the case the problem of the creation of an atmosphere of inquiry and research is much simplified. It is only necessary that we should ensure, for the men who can use it, a sufficiency of leisure and opportunity for the prosecution of original work. It is to be desired, however, that there should be some recognised organisation within the college for so dealing with the distribution of the routine duties of teaching and examination that this leisure may be obtained in a normal and regular way.

The problem of creating the proper atmosphere becomes more difficult if the regular staff does not comprise within itself men who, by natural endowment and training, are fitted to inspire and to organise the work of a body of research students. So far as I know, few, if any, of our institutions are yet in a position to add to their staff and equipment solely with the object of fostering pioneer work. Yet it occurs to me that this is a direction in which we shall have to move ere long, and the sooner we begin to familiarise our governing bodies with the idea, the better it will be for all concerned.

Returning, however, to the case of those institutions which already have on their staff men with the necessary endowments, we may consider the further needs of the students, of those who have been selected for their special capabilities. While mere pecuniary inducements are in themselves the most unsatisfactory means for the stimulation of the right kind of original work, yet it must be recognised that pecuniary considerations are likely to bulk considerably in the minds of the majority of the students with whom we have to deal. It must be assumed, I think, that the pursuit of research work in any serious sense can only be taken up after the ordinary curriculum has been completed. This means that the selected students must continue their association with the college as research students. It would therefore be necessary to provide scholarships of sufficient value to compensate them for the postponement of their entry into the ranks of the paid workers in industry. In some institutions a beginning has already been made in this direction, and as these experiments grow in magnitude and success we look forward to a wider recognition of the benefit to all concerned.

On the financial side of this question I am tempted to detain you by a very brief digression. In seeking for financial help for schemes of this kind we may find it of advantage to disabuse the mind of the "generous donor" of the idea that the only way in which he can help is by endowing our schemes by large grants of capital. Endowments of this kind are invaluable in certain directions, but there are schemes of a more tentative kind for which all that is required is a guarantee of the expenditure for a very few years. For example, our first research student can start to work so soon as a donor can be found who will guarantee the income of the student for one, two, or three years. The donor might thus provide 100*l*. a year for three years at a total cost of 300*l*. Whereas,

if he were asked to endow a fellowship of this annual value he would immediately have to hand over 3000*l*. This method certainly lends itself admirably to the making of untried experiments in educational as well as in other matters. I do not speak altogether without practical experience of the method, and I have therefore ventured to make this digression in order to commend it to your attention.

It is of set purpose that I have discriminated sharply between the functions of the technical college; the training of large numbers of competent craftsmen or professional men, and the development of a smaller class of scientific pioneers. We must admit that the latter function is likely to make the less effective appeal to the general public; indeed, it would be surprising if it were to appeal to more than a select few. I take this to mean that within the managing body we must be satisfied to proceed cautiously in developing this function. There need be no doubt or hesitation as to the *objects* to be attained, but prudence and caution will be required in the application of the means at our disposal. *Men* are of far greater importance than *money*, and I confess to a certain distrust of schemes of scientific research which are splendid mainly because they are splendidly financed. No great research department can develop except by a process which is analogous to organic growth. If the right kind of nucleus can be placed in a suitable environment we may rest assured that nature will do the rest by her processes of cell division and multiplication. It is our part to see that the nucleus is sound and of the right kind, to provide for it the necessary environment, and to weed out all useless and undesirable growths.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. R. C. Punnett has been appointed superintendent of the museum of zoology in succession to Dr. S. F. Harmer, F.R.S., who recently accepted the keepership in zoology at the British Museum (Natural History).

The Smith's prizes have been adjudged as follows:—H. W. Turnbull, Trinity College, for his essay, "The Irreducible Concomitants of Two Quadratics in *n* Variables"; G. N. Watson, Trinity College, for his essay, "The Solution of the Homogeneous Linear Difference Equation of the Second Order, and its Applications to the Theory of Linear Differential Equations of Fuchsian Type." The names are in alphabetical order.

Dr. McTaggart has been appointed chairman of the examiners for the moral sciences tripos, and Mr. H. O. Meredith chairman of the examiners for the economics tripos.

Sir Victor Horsley has been appointed Linacre lecturer at St. John's College, Cambridge. The lecture will be delivered on Thursday, May 6, the subject being "The Motor Area of the Brain."

LONDON.—Mr. G. A. Schott has been granted the degree of D.Sc. in applied mathematics as an external student, and Mr. G. W. C. Kaye has been granted the degree of D.Sc. in physics as an external student.

The medical college of the London Hospital has recently received a sum of 20,000*l*., which has been placed in the hands of trustees. The yearly income will be spent on the advancement of medical research and the promotion of higher education in medicine. The donor wishes to remain anonymous.

The Senate has taken exception to the terms of reference to the Royal Commission on the University on the ground that the scope of the inquiry is wider than was approved by the Senate at their meeting in December, 1908, and that the Senate has not been given the opportunity to consider extended terms of reference.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Dr. Sven Hedin for the degree of D.Sc. *honoris causa* on March 2:—"Gaudet profecto et sibi gratulatur Academia nostra dum salutat eum qui sicut Ulixes πολλῶν ἀνθρώπων ἴδεν ἄστεα καὶ νόον ἔγνω, qui Marci Poli, Christopheri Columbi, Alexandri Humboldt æmulus inter insignissimos orbis terrarum exploratores iure numerandus est. Quippe hic ille est Sven Hedin cuius itinera periculosa hodie in ore animoque omnium sunt. Civiles palmas non minus illustres esse quam bellicas aiunt: quod si verum sit, hunc virum tanquam victorem ornare possumus, cum de ipsa Natura faciem novercalem ostendente atque atrocissime minante victoriam reportaverit. Multas hic personas eadem laude gessit, modo exploratoris impavidi qui vel multis comitantibus vel solus secum deserta perlustrat, modo ducis benigni qui nudato pede calceis aqua repletis morientis calonis sitim levat, modo scientiæ cultoris qui labores tæterrimos perpessus regiones incognitas pedetemptim recludit. Quam diu ingentes Indiæ fluvii in Oceanum volventur, quam diu Asiæ interioris montes nivibus vestiti et aviæ solitudines manebunt, monumento hic vir non egebit."

M. DELAFOND will on July 1 next succeed M. E. Nivoit as director of the Paris National School of Mines.

THE London Inter-collegiate Scholarships Board will hold a combined examination for twenty entrance scholarships and exhibitions, tenable at University College, King's College, and the East London College, on May 11 and following days. No candidates will be admitted to the examination unless they have passed the London University matriculation or an equivalent examination, and are under the age of nineteen on May 1. The total value of scholarships offered is about 1500*l*. Full particulars and forms of entry may be obtained from the secretary of the board, Mr. Alfred E. G. Attoe, University College, Gower Street, W.C.

ANNOUNCEMENTS have been made in the Press that the Aërial League of the British Empire purposes to establish immediately a national aëronautical college. It is intended that the new college shall provide instruction in the subjects bearing upon aërial flight and navigation. Courses of study will be arranged in the mathematics, dynamics, and mechanics involved in the problem of flight, the laws of air resistance and friction, the stability of air craft, and in the meteorological, physical, and other conditions affecting aërial navigation. Workshops and laboratories, where experiments and tests can be performed, are to be included in the college, and a trial ground is to be procured. The intention is to teach completely the science and art of flying. It is satisfactory to find that the promoters of the scheme appreciate the necessity for founding practice upon scientific knowledge, and it may be hoped that the experiments to be performed will be based upon exhaustive theoretical inquiries into the mathematical principles which underlie the problems it is sought to solve by practical means.

THE annual report on the work of University College, London, shows that the total number of students during the session 1907–8 was 1361, being an increase of 170 on that of the preceding session. Of these, 229 were post-graduate and research students. The principal benefactions during the year were a bequest of 5000*l*. by the late Mr. Thomas Webb, of London and Cardiff, which is to be used for the completion of the new physiology building; a bequest of 500*l*. by Mr. H. A. Kay, to be used for the re-arrangement and re-equipment of the college buildings; a bequest of 1000*l*. by the late Prof. Bunnell Lewis; a bequest of 1541*l*. by the late Madame Halfon, for the foundation of prizes to be known as the "L. M. Rothschild" and the "Hester Rothschild" prizes; a gift by the past engineering students' committee of 410*l*., for the new equipment of the engineering departments; and a donation of 50*l*. by Mr. Yarrow, for the provision of apparatus in the mechanical engineering department. Besides the grants from the Treasury, the India Office, and the London County Council, the college benefited during the past year by grants from the Carpenters' Company for architecture, from the Chadwick trustees for municipal engineering and hygiene, from the Drapers' Company for applied mathematics, and from the Mercers' Company for physiology. Rapid progress has been made with the new buildings for the department of physiology, which will be ready for occupation next month. The re-arrangement and re-equipment of the college buildings involved an expenditure of 5988*l*. In order to assist the deans in the two most complex faculties, those of arts

and science, the office of sub-dean has been created to provide greater facilities for giving students advice. The organisation of the arrangements for post-graduate courses and for research has been improved. The report contains lists of original papers that have been issued during the past year. The activity of the department of applied mathematics, under Prof. Karl Pearson, including the Galton Laboratory for National Eugenics, is marked by the issue of twenty-seven publications, and that of the department of chemistry, under Sir William Ramsay and Prof. J. Norman Collie, by the publication of forty original papers. The report closes with a summary of the urgent needs of the college. The need for new buildings for the department of chemistry, at a cost of about 70,000*l*., is placed in the forefront. The Chancellor, the Earl of Rosebery, has intimated his willingness to subscribe 1000*l*. to a fund for the erection of new chemical laboratories. The expenditure for the year was 53,535*l*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 10, 1908.—"The Rotation of the Electric Arc in a Radial Magnetic Field." By J. **Nicol.** Communicated by Prof. H. A. Wilson, F.R.S.

It is well known that the electric arc is deflected by a transverse magnetic field. If the electrodes are tubular and the field is radial, spreading from an iron rod lying along the axis of the electrodes, the arc will travel round these continuously. If k_1 and k_2 are the velocities, due to unit electric force, of the ions carrying the charge, the transverse velocity of the arc is k_1k_2HX, so that a measurement of this velocity will give the product k_1k_2.

The measurement was made by placing a slit in front of the arc and allowing the light passing through this to fall on a rotating mirror, which reflected it into a photographic camera. The axis of rotation of the mirror almost coincided with the normal to its surface, and this caused the image of a point source to be a small circle. As the slit was only illuminated intermittently (once during each revolution of the arc) the image on the plate consisted of a number of dots arranged round a circle. Counting these enabled the velocity of the arc to be determined.

Copper arcs 1·8–3·6 mm. long, carrying currents from 2–9 amperes, were used. The magnetic field varied from 35–140 C.G.S. units, and the resulting arc velocities from 200–1100 cm. per sec.

The results of the experiments led to the formula

$$v = \mathrm{H}(2{\cdot}55 + 0{\cdot}74\,i)$$

connecting the velocity with the magnetic force and arc current. The values deduced for k_1k_2 lie between $0{\cdot}53 \times 10^7$ cm. per sec. per volt per cm. for a two-ampere arc and $1{\cdot}5 \times 10^7$ for nine amperes.

Langevin has given an expression for k in terms of the mean free path, and the agitation velocity of the particle $k = e\lambda/mu$.

This gives k for a corpuscle $1{\cdot}83 \times 10^4$, and this, combined with the experimental result 10^7 for k_1k_2, gives $5{\cdot}5 \times 10^2$ as the velocity of the positive ion. Since mu^2 is the same for all gases, Langevin's expression shows that $k \propto 1/\sqrt{m}$. Hence in the arc the positive ion is 900 times as heavy as a corpuscle. This mass is about the same as that found by Sir J. J. Thomson for the positive ions in the Kanalstrahlen, but much less than that of the atoms (Cu, N, or O) present in the arc.

February 11.—Sir Archibald Geikie, K.C.B., president, in the chair.—The nerves of the atrio-ventricular bundle: J. Gordon **Wilson.** In the introduction the author refers to the discovery of this muscular bundle and its function by Gaskell, also to the valuable work of his and the important research of Tawara upon the structure of this bundle. He points out that both Tawara and Retzer made definite statements of the existence in the bundle of nerve cells and fibres. The material used for this research was obtained from the pig, calf, and sheep; the technique employed was the methylene blue "vital" method. Conclusions:—I. Anatomically, the atrio-ventricular bundle contains, not only a special form of muscle fibre distinct from the ordinary muscle of the atrium or the ventricle, but also an important and intricate nerve pathway, in which we find:—(1) numerous ganglion cells, monopolar, bipolar, and multipolar, the processes of which may pass (*a*) to adjacent ganglion cells in the bundle, (*b*) to the muscle fibres in the bundle, and (*c*) through the muscle bundle so far as it was examined; (2) abundant nerve fibres running through it in strands, the processes of which may end (*a*) in ganglion cells in the bundle, (*b*) in the muscle plexus, or pass through the part examined; (3) an intricate plexus of varicose fibrils around and in close relation to the muscle fibres of the bundle; (4) an abundant vascular supply with well-marked vasomotor nerves and sensory endings. II. Physiologically it has been shown that the atrio-ventricular band constitutes the pathway which assures the communication of the atrio-ventricular rhythm. When the bundle is sectioned or crushed, the ventricles cease momentarily to beat, though they soon regain pulsation, but with a rhythm much more slow than that of the atrium. Pathological anatomy supports this view; the allorhythmia of Stokes-Adams disease can be explained satisfactorily by lesions involving this pathway. As a result of these physiological experiments, and from these pathological conditions, it has been asserted that the contraction wave must be myogenic. To such a deduction the author's anatomical findings are opposed. They demonstrate that in these experiments and pathological conditions an important nerve pathway is equally involved with the muscle bundle.—An experimental estimation of the theory of ancestral contributions in heredity: A. D. **Darbishire.** The modern experimental study of (bi-parental) inheritance is based on the assumption that the character of an organism is determined by the potentialities existent in the germ cells which produce it, and not by the nature of the parents of that organism or of its more remote ancestors. In other words, according to the former view, the attempt to predict the result of a given mating must be based on some theory as to the characters existent potentially in the germ cells of the two individuals mated, and the characters of the parents themselves and of the remoter ancestry may be left out of account altogether in the attempt to make this prediction. The present paper gives an account of an experiment designed to decide, in regard to a particular character, between these two fundamentally different theories. The result of a cross between a yellow-seeded pea and a green-seeded pea, both of pure race, is already well known. All the first generation (F_1) are yellow, and 25 per cent. of the next generation (F_2), produced by mating these yellow hybrids *inter se*, are green, the rest being yellow. These "extracted" greens, as they are called, are said to be produced, by the yellow hybrids, in the same proportion, in each successive generation (F_3, F_4, . . . &c.), according to a scheme which it is not necessary to give here. An extracted green in F_3, therefore, has a great "weight" of yellow ancestry behind it, inasmuch as no green appears in that ancestry nearer than the great-great-great-grandparental generation, whilst behind that half the ancestors are yellow and half green. The author has made a number of crosses between pure yellow strains and extracted greens in F_3. All the (F_1) hybrids thus raised were yellow, as might have been expected. With regard to the next generation, however, it is evident that if there is any truth in the view that the characters of the parents and ancestors play any part in determining the composition of a given generation, *less* than 25 per cent. green should occur in F_2 from this cross. No such result is obtained. The proportion of greens in F_2 is 24·88 per cent., the number of greens being 34,792 and of yellows 105,045. The probable error of the percentage is ±0·078. The actual deviation from the 25 per cent. expected, namely, 0·12 per cent., is not twice the probable error, and is therefore certainly not significant.—The determination of a coefficient by which the rate of diffusion of stain and other substances into living cells can be measured, and by which bacteria and other cells may be differentiated: H. C. **Ross.** When fresh blood is spread upon a film of agar jelly which contains Unna's stain and certain salts, the stain diffuses into the living cells, and the rapidity of diffusion depends on certain factors. It is accelerated by heat, and, of course, by time. If the jelly is alkaline, diffusion is also accelerated. Acids

and neutral salts delay it. It has been found that when one class of cell stains on a given agar film, other classes do not. By slightly altering the constitution of the agar, *i.e.* by adding more alkali, acid, or salts, or by trying a different temperature, &c., that class of cell which previously refused to stain will now absorb it. It has also been found that bacteria and other cells are subject to the same conditions, and by this means it has been possible to differentiate them by their rate or coefficient of diffusion. A simple method is given for the arrangement of the agar jelly; and by measuring in units the factors, heat, alkalies, acids, salts, and time, the coefficients of diffusion can be expressed in numerals with the aid of a simple equation, the staining of the nucleus, or the cytoplasm in unnucleated cells, being the moment by which the coefficient is determined. The staining of the nucleus is coincident with death. Conversely, when the coefficient of diffusion of a cell is known, the equation indicates how to arrange an agar film so as to cause staining of the cell in a given time at a given temperature. Examples are given, and among them is one which shows that the rate of diffusion of substances other than stains also appears to depend on the coefficient of diffusion of the cells. In addition there is a summary, and some suggestions are made as to possible practical applications of the subject considered in the paper.—The origin and destiny of cholesterol in the animal organism, part iii., the absorption of cholesterol in the intestine and its appearance in the blood: C. **Dorée** and J. A. **Gardner.** The authors, as a result of experiments already communicated to the society and a consideration of the work of previous observers, have been led, in the present paper, to formulate the following working hypothesis as to the origin and destiny of cholesterol in the animal organism:—(1) Cholesterol is a constant constituent of all cells, and when these cells are broken down the cholesterol is not excreted as a waste product, but is utilised in the formation of new cells. (2) A function of the liver is to break down dead cells, *e.g.* blood corpuscles, and to eliminate their cholesterol in the bile. (3) After the bile has been poured into the intestine in the process of digestion, the cholesterol is re-absorbed, probably in the form of esters, along with the bile salts, and carried by the blood to the various centres and tissues for re-incorporation into the constitution of new cells. (4) Cholesterol is probably not synthesised in the animal body, and any wastage of cholesterol is replaced by direct absorption from the food. With the view of testing this hypothesis, the experiments detailed in the communication were carried out. On feeding rabbits on food freed from cholesterol or phytosterol, no cholesterol could be found in the fæces. When, however, weighed quantities of cholesterol were added to this food, a certain proportion was always absorbed. Analyses of the blood of these animals showed an increase in the cholesterol content in the case of animals fed with cholesterol compared with those without cholesterol. Similar experiments carried out on dogs showed that cholesterol was also absorbed from their food. —The origin and destiny of cholesterol in the animal organism, part iv., the cholesterol content of eggs and chicks: G. W. **Ellis** and J. A. **Gardner.** This paper contains an account of a number of experiments carried out with the view of obtaining evidence of the truth of the hypothesis recently advanced, that cholesterol is strictly conserved in the animal organism, and that it is not synthesised by the animal, but taken into its organism as food, at any rate in the growing animal. The experiments detailed in this paper consist of a number of estimations of cholesterol in the total unsaponifiable matter obtained from hens' eggs and newly hatched chicks. The estimations were carried out with the greatest possible accuracy, and the results leave no doubt that there is no increase in cholesterol during the change of the ovum into the complex aggregate of cells constituting the newly hatched chick. The results seem to show a slightly lower percentage of cholesterol in the chick than in the egg, but this difference may be due to experimental difficulties in extracting all the cholesterol from the tissues of the chick. The average percentages of cholesterol in eggs and chicks are given in the accompanying table. The percentages of cholesterol in the chicks are given in terms of the weights of the original eggs:—

	Per cent.
6 eggs, analysed together	0·4896
6 eggs, analysed separately	0·4121
Average	0·4508
6 chicks, analysed together	0·4677
6 chicks, analysed separately	0·3633
Average	0·4155
Difference	0·0353

February 18.—Sir Archibald Geikie, K.C.B., president, in the chair.—The osmotic pressures of solutions of calcium ferrocyanide, part ii., weak solutions: the Earl of **Berkeley,** E. G. J. **Hartley,** and J. **Stephenson.** This communication records the observed equilibrium osmotic pressures from 25 to 5 atmospheres, and also the electric conductivities of the more dilute solutions; it is shown that to bring the two sets of observations into accord it is necessary to assume that the salt molecule is associated when in solution. Similar remarks apply to strontium ferrocyanide, and are not inconsistent with the data found for the potassium salt.—The spontaneous crystallisation of monochloracetic acid and its mixtures with naphthalene: Dr. H. A. **Miers** and Miss F. **Isaac.** In this investigation three different modifications (α, β, and γ) of monochloracetic acid are described, and the transformations from one modification to another. The behaviour of aqueous solutions of monochloracetic acid was investigated as the solutions cooled by means of observations on their refractive indices. These experiments lead to the establishment of three supersolubility curves separating the metastable and labile regions, corresponding to the three modifications of the acid. These supersolubility curves have also been verified by an independent method. Aqueous solutions of monochloracetic acid of various concentrations were enclosed in sealed glass tubes and heated until the crystals had completely dissolved. The temperatures at which the solutions re-crystallised spontaneously as either α, β, or γ crystals were found to agree with the temperatures at which the corresponding solutions passed from the metastable to the labile state as determined by the previous experiments. The three solubility curves for the three modifications of monochloracetic acid have also been obtained. The second part of the paper deals with mixtures of monochloracetic acid and naphthalene. These substances Cady describes as forming mixed crystals and possessing a minimum, or eutectic, freezing point (*Journ. Phys. Chem.*, 1899, iii., 127). In a long series of experiments, however, of which an account is given, there has never been any indication of the formation of mixed crystals. The melting and freezing points of a large number of mixtures were carefully determined, but in no case was there found to be any appreciable difference between these points. The study of the crystallisation of these mixtures therefore yields results similar to those obtained for salol and betol (Proc. Roy. Soc., A, lxxix., 1907), a new feature being introduced by the existence of the three modifications of monochloracetic acid. Four solubility curves have been traced, *i.e.* the solubility curve for naphthalene in monochloracetic acid, and the three solubility curves for the modifications α, β, and γ of monochloracetic acid in naphthalene. Each of the latter meets the naphthalene solubility curve in a eutectic point, thus giving three eutectic points. Similarly, four supersolubility curves for these mixtures have been determined, giving the temperatures at which naphthalene and the three modifications of the acid crystallise spontaneously. These curves intersect in three hypertectic points, showing the highest temperature at which naphthalene and each modification of the acid respectively can crystallise spontaneously together. The four solubility and four supersolubility curves when plotted on a diagram show that in a mixture of two substances, of which one exists in three modifications, eight freezing points may be exhibited by a cooling mixture.—An apparatus for measurements of the defining power of objectives: J. de Graaff **Hunter.** The general principle of the method of measurement employed may be stated as follows. The image of a knife-edge formed by a photographic lens, when viewed with a microscope, will no longer appear as a sharp edge; the illumination of the bright portion of the field will only gradually fade away to complete darkness at some position within

the line ideally representing the true image of the edge. The object aimed at is to measure the actual intensity of illumination in the image at different distances on either side of this ideal line. The variation in the illumination with the distance is, of course, very rapid, and the total distance over which it is necessary to carry the measurements is in general extremely small. To isolate the strip parallel to the knife-edge, the illumination of which is to be measured, a narrow slit is placed in the focal plane of the microscope objective, and is thus magnified by the eye-piece. To measure the intensity of the illumination seen through this slit—*i.e.* the illumination along a line parallel to the ideal image of the knife-edge—a special mechanism is employed, whereby this image is made to alternate with light from a constant source, which, however, can be varied in a measurable proportion, so as to become of equal intensity with the illumination to be measured. This equality is judged by the absence of "flicker" when the alternations are made to succeed one another with appropriate frequency.—Best conditions for photographic enlargement of small solid objects: A. **Mallock.** When it is desired to take an enlarged photograph of an object which is not flat, and which cannot, therefore, be in focus in all parts, the question arises as to what form of lens should be used in order to secure the best results. It is shown in the paper that if a certain minimum fineness of definition is required, say, the separation of points the distance apart of which is a_1, then, in the first place, the lens used must be capable of resolving points half this distance apart; and, secondly, that the greatest distance (b_3) of the surface from the focal plane must not exceed $a/2\alpha$, where α is the angular aperture of the lens. The resolving power of a lens being dependent on α and the wave-length, it is shown that if $a=n\lambda$, then $b=n^2\frac{1}{4}\lambda$ nearly. The best that can be done, therefore, in photographing a curved or uneven surface is to use a lens which will resolve half the least distance to be defined in the picture. If this be done, all points which are not within a distance a_1 of one another, and not more than $n^2\frac{1}{4}\lambda$ out of focus, will appear separated in the picture. On the other hand, if b is given, the least distance which will be resolved over the whole picture is $2\sqrt{(b\lambda)}$.

Zoological Society, February 16.—Mr. F. Gillett, vice-president, in the chair.—Fauna of the Cocos-Keeling Atoll: Dr. F. **Wood-Jones.** The work was based on collections made by the author during a stay of fifteen months in 1905 and 1906, and in the case of most orders was believed to be fairly complete.—The anatomy of certain Ungulata, including Tapirus, Hyrax, and Antilocapra: F. E. **Beddard.**—Le Rhinocéros Blanc du Soudan (*Rhinoceros simus cottoni*): Dr. E. L. **Trouessart.**

Institution of Mining and Metallurgy, February 18.—Mr. Alfred James, president, in the chair.—Adjourned discussion on a theory of volcanic action and ore deposits, their nature and cause: Hiram W. **Hixon.**—The following papers were also discussed:—An instance of secondary impoverishment: H. H. **Knox.** This paper dealt with deposits on the private estates of Kishtim, in the government of Perm, Russia, in which are occurrences of unoxidised iron sulphides, which have been leached of their copper contents. The mines particularly dealt with were a group comprising the Tissoff, Koniukhoff, and Smirnoff lodes in the Soimonorsk Valley.—"Shrinkage" stoping in Western Australia: F. Percy **Rolfe.** A description of the method of stoping used at the Lake View Consols Gold Mine, and a review of the advantages and disadvantages of the method as compared with the common system of stoping adopted in Western Australia by means of "mullock" or "filled" stopes. The reasons for utilising "shrinkage" stoping in this particular mine were stated, and the details of the method fully explained.

PARIS.

Academy of Sciences, February 22.—M. Émile Picard in the chair.—Hertzian waves and Fredholm's equation: H. **Poincaré.** It is shown that several problems relating to Hertzian waves can be reduced to the integration of a Fredholm's equation.—The sex in sea-urchins obtained by experimental parthenogenesis: Yves **Delage.** Two sea-urchins, which had survived their metamorphosis sixteen months, were accidentally killed by a change in their conditions of life. The determination of their sex showed that one was certainly, and the other probably, male. From this the conclusion is drawn that sea-urchins produced by experimental parthenogenesis can be raised to the adult state, characterised by the presence of the sexual elements, and that males can be thus obtained.—Electrical discharges in intense magnetic fields: M. **Gouy.**—The principles of intrinsic projective geometry: A. **Demoulin.**—Some figures determined by the infinitely near elements of a skew curve: B. **Hostinsky.**—The application of the generalised theorem of Jacobi to the problem of Jacobi-Lie: W. **Stekloff.**—The search for roots of certain numerical transcendental equations: R. **de Montessus.**—The statical graphics of the aëroplane: Léon **Lecornu.**—The force and power of propulsion of aërial helices: René **Arnoux.**—The thermal effects of a musical arc; the probable fusion of carbon: M. **La Rosa.** The amount of energy in a singing arc is much greater than in an ordinary arc possessing self-induction, and hence should possess a much higher temperature than the latter. By the action of a singing arc on sugar charcoal masses of graphite have been obtained possessing such firmness and tenacity as to suggest that the charcoal had been fused.—The constitution of subterranean telephone circuits in large towns: M. **Devaux-Charbonnel.** It has been known for some time that the presence of an underground section of a telephone circuit diminishes considerably the intensity of the voice, and particularly affects the distinctness of certain consonants. In the present paper a calculation is given showing the relation between a given length of air line and the corresponding length of underground cable. The most advantageous diameter of wire for the cable is also worked out, and the important advantages possessed by cables of small capacity indicated.—The existence of positive electrons in vacuum tubes: A. **Dufour.** The author has repeated the experiments of J. Becquerel on the existence of positive electrons in vacuum tubes, and has obtained the same experimental results. The author's interpretation of the experiments is, however, different from that given by M. Becquerel, and does not necessitate the assumption of the existence of positive electrons in the vacuum tube.—The atomic weight of potassium: G. D. **Hinrichs.** The author applies his methods of calculation to the recent data of V. Lenher, and concludes that the true atomic weight of potassium is 39·125.—The colour reactions of indol bodies with sugars: Julius **Gnezda.**—The chloralic acids: M. **Hanriot.** The substances obtained by combining chloral with various sugars have been submitted to oxidation; acids, which are called chloralic acids, are produced, the properties of a number of which are described.—Syntheses by means of the mixed zinc organo-metallic derivatives: E. **Blaise** and A. **Kœhler.** This general method of synthesis starts from the ester-acids of the type $CO_2Et.(CH_2)_n.CO_2H$, details being given of the best methods of preparing these acids. These are then converted into the chlorides

$$CO_2Et.(CH_2)_n.CO.Cl,$$

and then submitted to the reaction represented by the equation

$$CO_2Et.(CH_2)_n\,COCl + R.ZnI = ZnICl + CO_2Et.(CH_2)_n.CO.R.$$

Symmetrical diketones can also be obtained by a modification of the conditions, and the properties of a number of these are given.—The preparation of indazylic derivatives by means of hydrazo-orthoketones: P. **Carré.**—The nature of the cyano-compounds of Kirsch: X. **Rocques** and L. **Lévy.** The hydrocyanic acid in Kirsch two or three years old exists only partially in the free state, a part being combined with fatty derivatives of high molecular weight.—The coagulation of milk by the ferment of *Carica papaya*: C. **Gerber.**—Some new properties of the oxydases of *Russula delica*: J. **Wolff.**—The colloidal properties of starch with respect to its chemical constitution: Eugène **Fouard.** The rotatory power of a limpid solution of starch, obtained by filtration through a collodion film, is a function of the alkalinity of the liquid. As the amount of potash added is increased, the rotation tends to a limit

of 141°; this figure is nearly identical with the specific rotatory power of maltose in dilute solution (140°·4). The conclusion drawn from the whole of these experiments is that starch is a unique chemical species, and is simply a condensation product of maltose.—The maltases of maize: R. **Huerre.**—The digestion of mannanes and galactanes: H. **Bierry** and J. **Giaja.**—A mould in tanning with oil: André **Piedallu.** An account of the appearance of *Monascus purpureus* in various culture media. This fungus acidifies oils, thickens, and colours them brown; it secretes an oxydase, and appears to play an important part in the preparation of chamois leather.—The composition and utilisation of the pulp from sisal hemp after removal of the fibre: A. **Hébert** and F. **Heim.**—Comparison between the commencement of the development of a perennial and annual plant: G. **André.**—A variety of organic iron in plants: P. J. **Tarbouriech** and P. **Saget.** The plant *Rumex obtusiflorus* contains the highest proportion of iron in any plant yet known, and this iron is present in a form not reacting with the ordinary reagents for iron. The iron compound, which contains carbon, hydrogen, nitrogen, phosphorus, and iron (6·36 per cent.), is extracted from the root by alcohol containing 1 per cent. of hydrochloric acid.—Concerning the anatomy of the human thymus: Henri **Rieffel** and Jacques **Le Mée.** A reply to a criticism by M. Cruchet of a former paper by the authors.—The histological structure of the seminal receptacle of *Periplaneta orientalis*: L. **Bordas.**—The dangers of chloroform. Incoagulability of the blood and necrosis of the liver following after chloroform anæsthesia: M. **Doyon.**—The sterilisation of potable water by means of the quartz mercury vapour lamp: Jules **Courmont** and Th. **Nogier.** Potable water containing Eberth's bacillus or *Coli communis* is sterilised in one minute within a range of 30 cm. from the lamp.—Measurements in d'Arsonvalisation: E. **Doumer.**—The treatment of radiodermatitis by the high-frequency spark: M. de Keating **Hort.**—Diaphylactic centres: Pierre **Bonnier.**—The sense of orientation and topographical memory in *Patella vulgata*: H. **Piéron.**—The study of the geological distribution of the Bryozoa: Ferdinand **Canu.**

DIARY OF SOCIETIES.

THURSDAY, MARCH 4.

ROYAL SOCIETY, at 4.30.—On the Presence of Hæm-agglutinins, Hæm-opsonins, and Hæmolysins in the Blood obtained from Infectious and Non-infectious Diseases in Man (Second Report): L. S. Dudgeon.—The Action on Glucosides by Bacteria of the Acid-fast Group, with a New Method of isolating Human Tubercle Bacilli directly from Tuberculous Material contaminated with other Micro-organisms (Preliminary Note): F. W. Twort.—The Effect of Heat upon the Electrical State of Living Tissues: Dr. A. D. Waller, F.R.S.

ROYAL INSTITUTION, at 3.—Problems of Geographical Distribution in Mexico: Dr. Hans Gadow, F.R.S.

RÖNTGEN SOCIETY, at 8.15.—Some Vacuum Tube Phenomena: A. A. Campbell Swinton.

LINNEAN SOCIETY, at 8.—A Contribution to the Montane Flora of Fiji, including Cryptogams, with Ecological Notes: Miss L. S. Gibbs.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Some Commercial Aspects of the Management of Central Electricity Supply Stations: R. Borlase Matthews.

FRIDAY, MARCH 5.

GEOLOGISTS' ASSOCIATION, at 8.—On the Sections of Inferior Oolite on the Midford-Camerton Section of the Limpley Stoke Railway, Somerset: L. Richardson.—The Geology of the Paris Basin: F. D Ilfus.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Slips in Railway Earthworks: E. G. L. Lovegrove.

SATURDAY, March 6.

ROYAL INSTITUTION, at 3.—Properties of Matter: Sir J. J. Thomson, F.R.S.

ESSEX FIELD CLUB, at 6 (at Essex Museum, Stratford).—Some Essex Well-sections (Part iv): W. Whitaker, F.R.S.—Remarks on a Bone Object found at Braintree, Essex, and Comparison of Similar Objects found elsewhere: Francis W. Reader.—Insect Transformations: F. Enoch.

MONDAY, MARCH 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in Central Asia: Dr. M. A. Stein.

ROYAL SOCIETY OF ARTS, at 8.—Modern Methods of Artificial Illumination: Leon Gaster.

TUESDAY, MARCH 9.

ROYAL INSTITUTION, at 3.—The Evolution of the Brain as an Organ of Mind: Prof. F. W. Mott, F.R.S.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Veddas: Dr. C. G. Seligmann.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Concrete and Masonry Dam Construction in New South Wales: L. A. B. Wade.

WEDNESDAY, MARCH 10.

GEOLOGICAL SOCIETY, at 8.—Some Notes on the Neighbourhood of Victoria Falls: Thomas Codrington.—A Contribution to the Petrography of the New Red Sandstone in the West of England: H. H. Thomas.

SOCIETY OF ARTS, at 8.—The Application of the Microscope to the Study of Metals: Walter Rosenhain.

THURSDAY, MARCH 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Note on the Stability of Jacobi's Ellipsoid: Sir George H. Darwin, K.C.B., F.R.S.—On the Wave-lengths of Lines in the Secondary Spectrum of Hydrogen: H. E. Watson.—The Measurement of Dielectric Constants by the Oscillations of Ellipsoids and Cylinders in a Field of Force: Prof. W. M. Thornton.

ROYAL INSTITUTION, at 3.—Recent Advances in Agricultural Science: A. D. Hall.

MATHEMATICAL SOCIETY, at 5.30.—The Kinetic Image of a Convected Electric System in a Conducting Plane Sheet: Prof. J. Larmor.—On an Integral Equation: G. H. Hardy.—The Use of Generalised Line, Surface, and Volume Integrals in Electrodynamics: H. Bateman.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Dielectric Strength of Compressed Air: E. A. Watson.

FRIDAY, MARCH 12.

ROYAL INSTITUTION, at 9.—Modern Submarine Telegraphy: S. G. Brown.

PHYSICAL SOCIETY, at 8.—The Effect of Radiations on the Brush Discharge: A. E. Garrett.—On Pirani's Method of Measuring the Self-inductance of a Coil: E. C. Snow.—Exhibition of a High Potential Primary Battery: W. S. Tucker.—On the Least Moment of Inertia of an Angle Bar Section: H. S. Rowell.

MALACOLOGICAL SOCIETY, at 8.—Description of a New Species of Oliva from the Andaman Islands: F. G. Bridgman.—Notes on the Genera Cypræa and Trivia: H. O. N. Shaw.—On the Shell Mound at Sidon; On the Habitat of Certain Species of Clausilia from the Coast of Syria: Rev. H. A. Cooke.—Notes on the Species of Cyclophorus found at Hong Kong: Staff-Surgeon K. H. Jones, R.N.—On the "Conchological Illustrations," by G. B. Sowerby, jun., and the "Descriptive Catalogue of Shells," by J. E. Gray: C. Davies Sherborn.—On the Date of Issue of Sowerby's "Conchological Illustrations": H. O. N. Shaw.

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