Nature

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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.

R. CLAY AND SONS, LTD., BREAD ST. HILL, E.C., AND BUNGAY, SUFFOLK.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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THURSDAY, MAY 7, 1903.

THE SCIENCE OF FLOUR MILLING.

Le Froment et sa Mouture. Par Girard et Lindet. Pp. vii+355. (Paris: Gauthier-Villars, 1903.) Price 12 francs.

AT the time of the regretted death of Prof. Girard in 1898, much valuable scientific work had been accomplished by him, and the results given to the world at large. But as must almost of necessity occur when a busy man is taken away from his labours, there also remained some tasks commenced but not completed. Among these was a projected treatise on flour milling, of which, however, Prof. Girard left but the general plan and the unfinished manuscript of three chapters. These materials were entrusted to M. Lindet, who has completed the work and supplied the book now before us. The author refers to the fact that neither himself nor Prof. Girard was a practical miller, but that the book is the production of two men of science. An examination of its pages shows it to possess those merits which might be expected from the previous training of the writers, and also, it must be added, the defects which spring from the same cause.

The first chapter deals with the production of wheat in various French districts, and also with the corn markets of Paris and the provinces. In passing, it may be noted that in France, as well as in England, they still suffer from the adoption of different systems of weights and measures in the different local corn markets. Thus, Troyes has a unit of 121 kilos., while La Charente adopts 80 kilos. as its measure, and other markets intermediate quantities. The authors deplore the grave inconveniences which result from such differences, and look forward to a time when the metric quintal shall have been universally adopted. With France as the birthplace of the metric system, there is perhaps some consolation in knowing that England is not the only country ruled in this matter by old-fashioned conservatism.

Following on this introduction, the writers next deal with the chemical composition and the alimentary value of the different parts of the wheat grain. The botanical distinctions between such parts and their separation and estimation are first described, tables being given which show the relative percentages of envelopes, germ, and flour-producing kernel or endosperm in leading types of wheat. The histology, chemical composition, and analysis of the envelope are next given, particular attention being devoted to the constitution of cerealin and the important *rôle* it plays in the process of panification. In pursuit of this line of investigation, the influence of the various parts of the envelope on those milling products which ultimately find their way into the flour is examined very minutely. The experiments and arguments of Mège-Mouriès are followed closely, and his conclusions to the effect that the inclusion of branny particles in flour results in the production of dark-coloured and inferior bread are fully endorsed. The authors further conclude that the branny matters of wheat are devoid of utility for purposes of human alimentation, being practically undigested by man, and consequently inassimilable. An experiment made by Prof. Girard on himself is described at full length. Being in perfect health, and with the digestive faculties in excellent condition, he ate a quantity of pure wheat grain envelopes, and analysed these when excreted at the close of the process of digestion. The necessary precautions were of course taken to ensure exact and trustworthy data being obtained, and Prof. Girard's results show that there is practically no assimilation of proteid bodies from the bran ingested. There is, however, a certain absorption of mineral substances, but this only amounts to 4 grams of mineral matter per kilogram of bread made from "entire flour" (wholemeal). Having regard to the quantity and variety of such matter in a modern diet, the authors regard the gain of these 4 grams as having no serious importance, and, in a word, condemn entirely and without reserve the inclusion of the bran in wheaten flour.

In studying the action of the germ, the authors are impressed with the fact that fresh germ has a characteristic odour and flavour which are in themselves pleasant. They further recognise that germ contains

a large percentage of proteid and oily matter, in consequence of which the nutritive value is high. But the proteid matter contains an active ferment, and the oil is of a highly oxidisable nature, readily becoming rancid. For these reasons they do not hesitate to assert that the germ, as well as the bran, should be rejected in the act of making flour, the farinaceous endosperm being the only component of the wheat grain which ought to be used as human food. It is interesting to note that the problem of the utilisation of germ has been much more successfully attacked in England than on the Continent. The credit is due to an English miller of discovering the fact that on subjecting germ to the action of slightly superheated steam the diastasic properties of the proteids are destroyed, while the oil is so fixed as to lose its natural tendency to rancidity. Germ treated in this manner and then mixed with ordinary white flour produces a bread of pleasant flavour and of high nutritive value.

The endosperm or kernel of wheat consists principally of proteid matters, starch, and products of starch hydrolysis. Of these substances the proteid matter has received the closest attention, the whole general character of each particular variety of wheat, and of its resultant flour, being governed by the quantity and quality of the proteid bodies contained. It has been recognised from the time of Liebig to the present that the proteid matter of wheat is not a single compound, but a mixture of several distinct substances. Among these are small quantities of bodies soluble in water or dilute saline solutions respectively (albumins and globulins); but the greater portion is not soluble in either of these reagents, but forms with water a tough india-rubber-like body, to which the name of gluten has been given. This substance is readily prepared by carefully kneading and washing in a stream of water a piece of dough from wheaten flour. The starch and soluble matters are thus eliminated, and the gluten remains behind. The body thus obtained, known as wet gluten, contains about two-thirds of its weight of water, the remainder being approximately pure proteid. By appropriate means, gluten is capable of being separated into two, and possibly three, different substances, possessing distinct and characteristic chemical and physical properties.

The most exhaustive examination of these bodies has been made by Osborne and Voorhees, who in 1893 communicated their results to the *American Chemical Journal*. Following much the same lines of research as other investigators, they treated gluten and flour itself respectively with dilute alcohol (0·90 specific gravity). This reagent dissolves a considerable quantity of proteid matter from both the previously washed gluten and the untreated flour, the proteid being the same in both instances. (Albumin and globulin are insoluble in dilute alcohol.) To this proteid the name of gliadin has been given. Of gluten, the insoluble portion has been called glutenin. Osborne and Voorhees describe gliadin as being, when obtained in the dry state from a solution in weak alcohol or water, an amorphous transparent substance closely resembling pure gelatin in appearance. It is slightly soluble in distilled water, but is instantly precipitated by a trace of common salt. Gliadin is very soluble in dilute alcohol (70 to 75 per cent.). As may be assumed from its mode of preparation, glutenin is insoluble in such alcohol, and also in water and dilute saline solutions. When freshly precipitated and hydrated, glutenin is soluble in 0·1 per cent. potash solution, and also in the slightest excess of sodium or potassium carbonate solution. Osborne and Voorhees made analyses of spring and winter American wheat flours respectively, each of which is a perfect flour of its kind, and found them to yield gliadin and glutenin in the following proportions :—

	Spring flour.	Winter flour.
Gliadin	45·8 ...	48·4
Glutenin	54·2 ...	51·6
	100·0	100·0

These quantities are roughly, it will be noticed, half and half, whereas M. Fleurent, whose results are adopted by MM. Girard and Lindet, states that the ideal composition of gluten is 75 parts of gliadin to 25 parts of glutenin. With such a composition the resultant bread will be well-risen and easy of digestion; but if the proportion of gliadin is higher, the bread will rise well during fermentation, but will fall in the oven, thus producing a heavy loaf as the result of the liquefaction of gliadin in the presence of water, under the influence of heat. But if the glutenin be in excess, the dough will be comparatively inelastic, and will not rise in baking.

There is evidently a great discrepancy between the results obtained by Osborne and Voorhees and those given in the work before us. It is to be regretted that MM. Girard and Lindet do not point out more clearly that in determining the percentage of gliadin M. Fleurent has made a radical departure from the method of Osborne and Voorhees. Instead of using pure dilute alcohol as a solvent, M. Fleurent employs 70 per cent. alcohol containing 3 parts of caustic potash per 1000. If, as stated by Osborne and Voorhees, glutenin is soluble in 0·1 per cent. potash solution, it is evident that it is readily soluble in a solution of the strength employed by M. Fleurent. After thus dissolving in dilute alcoholic potash solution, M. Fleurent passes carbon dioxide gas to saturation; but although potassium carbonate is insoluble in absolute alcohol, it is soluble in alcohol of 70 per cent., and so one has at the close of the experiment, not a solution of gliadin in dilute alcohol, but a solution of gliadin and a portion of the glutenin in a dilute alcohol-and-water solution of potassium carbonate. It is in consequence of this difference in their respective methods that the proportions of gliadin and glutenin found by these investigators differ so markedly from each other. No reflection whatever is cast upon the method of M. Fleurent as a means of judging the quality of a sample of flour, but it is unfortunate that the separation thus obtained is throughout spoken of by MM. Girard and Lindet as being one of gluten into gliadin and glutenin.

The examination of the more purely chemical part of this book has occupied space to the exclusion of the other subject-matter of the book. In later chapters

are contained an interesting historical *résumé* of the development of milling processes, which in turn is followed by a detailed description of wheat-storing buildings, silos, elevators and the like. The whole process of wheat cleaning, both by dry and wet methods, is described. In the next place, there is an account of the reduction of grain to flour, both by the old mill-stone process and the more modern one of gradual reduction by means of roller mills. The plan-sifter and other methods of separating flour from bran and germ next occupy attention. Having thus traced the whole operation from the raw grain to the finished flour, the authors devote a concluding chapter to flour analysis, modes of preservation, and a description of the channels through which, as a matter of commerce, it reaches the consumer. Of particular interest in this connection is the description of the "Twelve Marks" Market of Paris, and its mode of classifying and valuing flour according to a carefully selected standard of quality.

That M. Girard did not live to see the completion of his work is a matter sincerely to be regretted, but M. Lindet is to be congratulated on having produced, from the materials placed at his disposal and his own researches, a work of the keenest interest to chemists, and one that should prove of great value to the milling industry. WILLIAM JAGO.

PHYSIOLOGICAL RESULTS.

Ergebnisse der Physiologie. Erster Jahrgang. II. Abteilung. Biophysik und Psychophysik. Pp. xviii+926. (Wiesbaden: Bergmann.) Price 25 marks.

IN the present day, when the man of science is becoming more and more overwhelmed by the ever-increasing flood of literature, any methods which can assist him in some degree to surmount the flood may cordially be welcomed. Year-books and Centralblätter are useful in affording abstracts of current literature, but such abstracts, necessarily disconnected, are apt to engender disconnection and incompleteness of thought in their readers. Moreover, mixed fragments of literature are exceedingly difficult to assimilate, in comparison with connected and critical surveys extending over a definite range of some stated subject. We must therefore express our warm approval at the publication of the first volumes of this new physiological annual. As the name might imply, this "Ergebnisse der Physiologie" is comparable in character to the well-known "Ergebnisse der Anatomie und Entwickelungsgeschichte," which has proved of great service to zoologists, and to the no less valuable "Ergebnisse der allgemeinen Pathologie." In the words of the editors (L. Asher and K. Spiro), the present "Ergebnisse" will consist of original and critical essays upon various subjects or special points in physiology, which as the result of fresh research have acquired an especial interest. As the "Ergebnisse" will appear annually, they hope that in course of time as far as possible every branch of the science will receive its due attention.

With this commendation, we may perhaps be permitted to offer some little criticism as to the range of subjects which the editors propose to include within their jurisdiction. Dealing only with what they term "Biophysik" and "Psychophysik," with which the volume under review is alone concerned (and which represent only half the complete annual), it appears that in addition to purely physiological matters, the editors intend to include essays covering a wide range of general physiology. The physiology of protoplasm is, of course, quite rightly included, but it is distinctly open to question whether biological problems such as inheritance and adaptation had not better be omitted. The present volume of "Ergebnisse," for instance, includes a very long article on Regeneration, although this subject is dealt with regularly every year in the aforementioned "Ergebnisse der Anatomie." Again, the editors intend to include articles on physiological psychology (*e.g.* simple psychical processes, reaction time, sleep, hypnotism). All these extraneous subjects go to swell the size of the volumes, and render them unwieldy. Thus this first year's issue runs to two volumes of about 900 pages each, or double the bulk of the anatomical "Ergebnisse," which in its earlier numbers much more reasonably confined itself to a single volume of about 700 pages. There must be many a working physiologist who would gladly subscribe to a volume of this character, but who would be deterred by the bulkiness and expense of the present issue. Moreover, it is difficult to see how the multiplication of articles in the present "Ergebnisse" can be kept up in the future, unless special points be dealt with in wholly unnecessary detail. So great is the total amount of ground covered that it almost seems as if one or two more years' issues would include the whole range of physiology. Subsequent essayists would accordingly have to rely almost entirely on new work, or their articles would practically resolve themselves into year-book abstracts. It is to be hoped, therefore, that the editors may see fit in future years to curtail the size of their volumes. This should be done, not only by diminishing the number of articles, but by diminishing their length. Many of the essays in the present volume, as, for instance, those of Prof. Tigerstedt on intracardial pressure, of Prof. Starling on the movements and innervation of the alimentary canal, and of Prof. Hensen on the physiology of hearing, are of a moderate and most convenient length; but others, such as those of C. v. Monakow on cortical localisation (132 pages), of A. Tschermak on adaptation of the eye to light, and the function of the rods and cones (106 pages), and of F. B. Hofmann on vision as affected by strabismus (46 pages), must be regarded as unnecessarily detailed, admirable as they may be in themselves. On the other hand, one or two articles err on the side of brevity, especially that of H. Boruttau on the innervation of respiration (6 pages), and to a less extent that of H. Meyer on nerve and muscle poisons (15 pages).

Another matter deserving of criticism is one which in future issues will doubtless to some extent be rectified. It concerns the lack of uniformity in the treatment of their subjects observed by the various essayists.

This is especially noticeable as regards the bibliography. Many of the essayists hit a happy mean, but H. Przibram actually gives 31 pages of references in his 77-page article on regeneration, whilst v. Monakow gives 846 distinct references, occupying 27 pages. Prof. Biedermann sins in the opposite direction, and in his otherwise comprehensive and instructive article on electrophysiology, sometimes mentions authors without giving any clue to their papers. Again, several of the articles are well illustrated (especially v. Monakow's important article on cortical localisation, which has eight plates), and it would be well if this most useful feature could be extended to certain other of the articles, though doubtless the question of expense comes in here.

In the limits of a short notice like the present one, it is impossible even to mention the titles of all the essays, but reference may be permitted to a few, over and above those already cited. P. Jensen gives a useful description of protoplasmic movement, and the effects of external conditions upon it, whilst J. von Uexküll writes a philosophical essay on the psychology of the lower animals. O. Langendorff enters very thoroughly into the properties of cardiac muscle, and discusses the nature of heart contraction, whether nervous or myogenic. L. Asher treats of certain aspects of the vaso-motor system, and R. du Bois-Reymond deals fully with the mechanics of respiration. H. E. Hering writes at some length on the central nervous paralysis of skeletal muscles (*e.g.* reflex inhibition, antagonistic muscles, decerebrate rigidity), whilst P. Grützner treats of the voice and speech, and H. Zwaardemaker of smell.

Finally, a word of praise must be accorded to the admirable manner in which the volume is printed. The large and well interspaced type renders reading a pleasure. Also printer's errors are remarkably infrequent. H. M. VERNON.

PHYSICAL CHEMISTRY AND BIOLOGY.

Physikalische Chemie der Zelle und der Gewebe. Von Dr. Rudolf Höber, Privatdocent der Physiologie an der Universität Zürich. Pp. xii + 344. (Leipzig: W. Engelmann.) Price 9*s.* net.

THE keynote to this interesting volume is found in the beautiful quotation from von Humboldt with which the author introduces his preface.

"Es ist die Sitte derer, die gerne andere auf den Gipfel der Berge führen möchten, dass sie den Mitreisenden den Weg gebahnter und anmutiger schildern, als man ihn finden wird, und dass sie die Aussicht von den Bergen rühmen, auch wenn sie ahnen, dass ganze Teile der Gegend in Nebel verhüllt bleiben werden. Sie wissen, dass auch in dieser Verhüllung ein geheimnissvoller Zauber liegt, dass eine duftige Ferne den Eindruck des Sinnlich-Unendlichen hervorruft, ein Bild, dass im Geist und in den Gefühlen sich ernst und ahnungsvoll spiegelt."

The author proves himself in the subsequent pages of the volume just such an inspiring guide as this, and points out the varied prospects from many points of view in his different chapters.

The book is interestingly written throughout, and although space makes it impossible to mention all recent work in the applications of the new advancements of physical chemistry to biology, the work is thoroughly up to date in most important directions of this extensive field of research.

The author states in his preface that the book is intended as a first review of the subject for those who may subsequently study in larger text-books, and be stimulated thereby to aid in its development; but, in the opinion of the reviewer, the book will be found most interesting to those who already possess a considerable acquaintance with physical chemistry, and desire a comprehensive and suggestive review of its relationship to biology and physiology.

Parts of the subject, such, for example, as the development of the ionic theory, and equilibrium in solution, are from the size of the book presented in such concise form as to make anything but easy reading for a beginner at the subject; while others, such as the permeability of the cell membrane, the physical theory of the action of anæsthetics, absorption, secretion and lymph formation, form attractive reading, and demand little special previous knowledge of the subject.

The physical chemist owes to the biologist the earliest experimental work upon osmotic pressure and its relationship to molecular weight. It was the study of osmosis and osmotic pressure by Pfeffer and Traube on account of its relationship to cell life which chiefly led to the conception that substances in solution behave in certain respects like gases, and this formed the starting point for the physical chemistry of solutions.

For this early service biologists are now being repaid by the great opportunities which increased knowledge of physical chemistry is giving in the prosecution of the study of the chemical and physical processes taking place in the cell.

In this development of biology based on physical chemistry, the work is not being done solely by physical chemists, on the one hand, or by biologists on the other, but important contributions have been and are being made to the common store by both biologists and physical chemists. A perusal of the book before us demonstrates most clearly this mutual relationship between physical chemistry and biology, for in the names of authors one finds those both of important biologists and physical chemists.

It is along this line of physical chemistry, so far as one can foresee, that the most important and rapid growth in biology will take place in the near future, and hence it is most important for either following or taking a share in these developments that every biologist should also be acquainted with recent progress in physical chemistry. Certain portions of the book may specially be recommended to those who desire in a short space to learn something of the close practical relationship of physical chemistry to biology and also to medicine, such as that on the solubility of uric acid, urates, and the purin bodies, and on the action of indicators, pp. 88 to 101; the permeability of the cell-membrane, especially that portion dealing with the action of anæsthetics, pp. 101 to 134; action of ions upon cells, pp. 134 to 146, and 171 to 184; methods of

physico-chemical analysis, pp. 206 to 251; and lastly, the most interesting account given on pp. 272 to 315 of the physical chemistry of ferment action, and of Bredig's recent discovery of inorganic ferments.

The whole volume well deserves careful reading, and it is to be hoped that it will find a wide circle of readers amongst workers in all divisions of the very comprehensive subject of biology.

BENJAMIN MOORE.

OUR BOOK SHELF.

Contribution à l'Étude du Mode de Production de l'Electricité dans les Êtres vivants. Par M. le Dr. Louis Querton. Pp. 180. (Bruxelles: Lamartin, 1902.)

THIS contribution to the existing literature upon the subject of vital electromotive phenomena contains some new researches which support the view advocated by the author that the electrical changes in living tissues are caused by definite chemical processes. The view is not a new one, and its advocacy in the present publication appears to have been called forth by the attitude taken by Mendelsohn in his article upon the subject in the "Dictionnaire de Physiologie," edited by Prof. Richet; this attitude is described by Dr. Querton in the following quotation from M. Mendelsohn's article:—

"The conception of the chemical origin of the electrical phenomena observed in nerve and muscle is purely hypothetical."

Dr. Querton has done useful service in bringing together additional evidence that the electrical phenomena are in many cases the indications of definite chemical processes. The author gives a brief review of the general features of the phenomena in electrical organs, muscles, nerves, the eye, glandular tissue, the skin and the leaves of plants; he then describes observations of his own as to the direct connection between such electrical phenomena in plant leaves as are produced by the action of light and (photo-)chemical changes in the chlorophyll; he follows these by a description of photo-electric phenomena occurring in solutions of oxalic acid, &c.

As regards the general review, this is admittedly scanty, particularly in the part which deals with the electric organs of fishes, and in dealing with this portion of the subject the author does not appear to have recognised that recent observations point to the conclusion that the electrical organs of fishes are to be classed among nervous, and not among muscular, structures. The author's own researches show that electromotive effects may be rapidly developed, and may rapidly subside in correspondence with the similar development and subsidence of chemical changes of comparatively small amount, and this result appears to support the view of chemical causation which he advocates. It must, however, be admitted that in nervous tissues, chemical change is so slight or so masked as to give no indications of its occurrence unless, indeed, the electrical alterations are assumed to be such indications, an assumption which, for the purpose of the argument, is logically unsound. Even in the case of the pronounced electromotive effects observed in the electrical organs of fishes there is the same lack of evidence, and it would therefore seem that provided the chemical change is of a certain type, a relatively insignificant chemical alteration may be associated with very definite electromotive effect; in this connection the possibility of the occurrence of surface tension changes as the result of chemical alteration might have been treated by the author with great advantage.

The impression left on reading the author's conclusions is that, although these indicate that one antecedent of the electromotive phenomena observed in living tissues is chemical change, the more interesting question as to whether this chemical antecedent is a remote or an immediate factor in their causation remains untouched.

Statics by Algebraic and Graphic Methods. By Lewis J. Johnson, C.E. Pp. viii+134; with six plates. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 2 dollars.

FROM the preface we infer that the author has set out with the object of providing engineering students with a text-book of small compass in which the elementary parts of statics are treated on a deductive basis, and analytical and graphical methods of solution are treated side by side.

It cannot be said that the book fulfils either of these objects as adequately as it should. The proofs of the conditions of equilibrium and of the parallelogram of forces are so unsound that it would be far better to replace them by a few definite axiomatic statements. As an example, take the statement in the footnote on p. 14 (in connection with the moment of a force about a point), "For assuming the point to be fixed is really assuming it to be always subject to a force equal, opposite and parallel to the given one."

In regard to the graphic solution of problems, it is possible that when a student has been told how to draw a force diagram, he may apply the method to an example, and actually measure the lines representing the forces, the only drawback being that in the questions the angles of the figures are not specified, and the figures are too small to give good scale diagrams without this help. The so-called algebraic solutions are too suggestive of the well-known type of examination answer, "By taking moments the resultant can be found." This usually means that the candidate cannot find it. The best feature of the book is the set of six typical problems which are actually solved by both methods on the plates at the end.

De l'Expérience en Géometrie. Par C. de Freycinet. Pp. 178. (Paris: Gauthier Villars, 1903.) Price 4 francs.

THE author discusses the question whether geometry is purely a rational science or whether it also possesses an experimental side. The question is dealt with in connection with (1) the concepts of geometry, (2) geometrical axioms, and (3) the propositions the establishment of which forms the object of deductive geometry. In the first chapter, M. de Freycinet finds no *a priori* reasons for the existence of such concepts as space, straight line, curved line, plane or curved surface, volume, angle, parallelism, tangency. These and other concepts are all suggested to us by our perception of the material universe. Passing on to the axioms relating to the straight line and plane, the author considers that it can in no sense be regarded as a self-evident truth that the straight line is the shortest line between two points, that a straight line can be produced indefinitely in either direction, or that two straight lines cannot have two points in common. These and other similar facts can only be regarded as results of experience and observation. In comparing the purely geometrical methods of the ancients with the analytical methods of Descartes and Leibnitz, the latter methods will be found in reality to be no less concrete in their foundations than the former. They do not discuss the geometrical truths of which they make use, but they accept them as evident, relying on pure geometry to establish them.

The general conclusion is that geometry is largely based on the results of experience. M. de Freycinet's book should prove of great interest to all who devote attention to the teaching of geometry.

Étude des Phénomènes volcaniques: Tremblements de Terre—Eruptions volcaniques—Le Cataclysme de la Martinique, 1902. Par François Miron. Pp. viii + 320. (Paris: Ch. Béranger, 1903.)

THE ground which this little work is intended to cover is so vast that it is impossible for the author to deal with any part of the subject in an adequate manner. Seismology is dismissed in twenty-seven pages, which serve only to give a most misleading impression of the present state of our knowledge of that science. The ninety-nine pages devoted to volcanic eruptions furnish only a short sketch of the subject, such as may be found in any treatise on geology, though here and there matters not ordinarily treated of in text-books may be met with, such as Fouqué's method of collecting gas at fumaroles. The thirty-eight pages devoted to the causes of vulcanism contain summary statements of the views of de Lapparent, Fouqué, Stanislas Meunier, Gautier and others, the author giving greatest weight to astronomical causes as possibly determining volcanic outbursts! To the phenomena following volcanic eruptions sixteen pages are devoted, while an account of the principal volcanoes of the globe occupies forty-two pages. The description of the Martinique and St. Vincent eruptions has, however, seventy pages devoted to it, and the work concludes with chapters in which vulcanism and the riches of the globe are discussed, such matters as mineral veins, thermal springs, and the occurrence of petroleum being hastily passed in review.

It is difficult to understand what useful purpose a compilation of this kind can serve, but, as the author says in his preface, general attention has been attracted by the catastrophe of St. Pierre, and there seems to be a demand for some kind of popular information on the subject. The supply possibly meets the demand, but both are probably ephemeral.

Experiments with Vacuum Tubes. By Sir D. L. Salomons, Bart. Pp. vii+49. (London: Whittaker and Co., 1903.) Price 2s.

GIVEN a well-equipped physical laboratory and an expert glass blower as assistant, one could pass many a pleasant hour in repeating the experiments described in this little book. The phenomena exhibited by vacuum tubes are perhaps the most fascinating that electrical science can show; they possess a rare and peculiar beauty which, like that of the rainbow or the Aurora, appeals to both the æsthetic and the scientific senses. Sir David Salomons describes how tubes may be constructed to produce certain definite results in the arrangement of striæ and so forth, and many of the designs give evidence of painstaking ingenuity. A number of experiments with tubes and magnets are also described, some of which serve to illustrate well the mutual action of electric currents and magnetic fields. The author does not deal with those phenomena which, in the hands of Sir W. Crookes, J. J. Thomson and others, have led in recent years to results of such importance; indeed, the theoretical explanations which are given as a running commentary on the experiments seem rather to show a lack of appreciation of the essential facts which have added such interest to the behaviour of the electric discharge in high vacua, and have raised the vacuum tube from the position of a scientific toy to that of a powerful instrument of research. M. S.

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.*]

Energy Emitted by Radio-active Bodies.

PROF. J. J. THOMSON'S interesting article in last week's NATURE raises the question of how long the emission of energy by radium may be expected to continue. I think in this connection that it would be of great importance to determine, if possible, whether radium, as contained in pitchblende, emits as much energy as the same amount of the material in the form of an artificially concentrated product. The mineral must be supposed to have been in existence, in its present condition, for a period of time comparable with the age of the earth—perhaps 50 million years. It is certainly more likely to have lost than gained activity during that time. We may therefore reasonably assume that it has been liberating energy at not less than its present rate for 50 million years. A determination of the amount of energy thus emitted would carry us much further than the most careful and protracted observations on powerful radium preparations.

Such a measurement would, no doubt, be difficult, but not, I think, altogether impracticable. A very large block of pitchblende might be used, and a thermocouple inserted in the centre of it. Something might be gained by careful heat insulation of the block.

A rough calculation will show the rise of temperature to be expected.

Consider an infinite slab of pitchblende bounded by two plane faces, the axis of x being perpendicular to these faces. Take an elementary slice, of thickness δx, at distance x from the face, and bounded by planes parallel to it.

The outflow of heat per square cm. from this slice is $-k\frac{d^2\theta}{dx^2}\delta x$,

where k is the thermal conductivity, and θ the temperature.

When a steady state has been reached, this must equal the rate of generation of heat in the slice per square cm. $= q\delta x$ suppose.

Thus $$-k\frac{d^2\theta}{dx^2}\delta x = q\delta x,$$

or $$\frac{d^2\theta}{dx^2} = -\frac{q}{k},$$

and by integration $\theta = \frac{-q}{2k}(x^2 + ax + b)$.

If the faces of the slab are maintained at 0° C., and if the slab is 1 metre thick, we have

$$\begin{cases} \theta = 0 \text{ when } x = 0, \\ \theta = 0 \text{ when } x = 100. \end{cases}$$

Thus $$a = -100,\ b = 0,$$

and $$\theta = \frac{-qx}{2k}(x - 100).$$

We may take for k the value 0·005, which is a rough general average for the conductivity of rocks.

It was found by Curie that 1 gram of radium emitted 100 calories per hour. If we suppose that the density of the radium is 3, and that pitchblende contains one part of it in 100,000 by volume, then, if the pitchblende is as active as one would expect from the proportion of radium contained, we should have

$$q = \frac{1}{1200000}.$$

We can now calculate the temperature to be expected at any point of the slab. In the middle, where $x = 50$, we find

$$\theta = \tfrac{1}{8} \text{ nearly.}$$

So that the middle of the slab would be $\frac{1}{8}$° hotter than the faces.

In practice the difference of temperature available would be less, since the block used would not take the form of an infinite slab. But still, the effect would probably be measurable. R. J. STRUTT.

The Fossil Man of Lansing, Kansas.

A GOOD deal of discussion has recently been aroused in America by the discovery of the so-called "fossil man of Lansing." It seems worth while considering the probable stature of the individual to whom the bones belonged. Prof. S. W. Williston, of Chicago, gives in the *Popular Science Monthly* for March (p. 470) the following values for the bone lengths, without, however, stating how the measurements were taken:—Femur, 43·0 cm.; Tibia, 35·0 cm.; Humerus, 30·2 cm.; Radius, 25·0 cm. From my memoir on the "Reconstruction of the Stature of Prehistoric Races" (*Phil. Trans.*, vol. cxcii. A, pp. 169–244), by using the formulæ on p. 196 Dr. Alice Lee has obtained the following results in cms.:—

Bones used in Reconstruction	Supposed ♂	Supposed ♀
(*a*) Femur	162·1 ...	156·5
(*b*) Humerus	158·0 ...	154·6
(*c*) Tibia	161·8 ...	157·1
(*d*) Radius	167·7 ...	164·8
(*e*) Femur + Tibia	161·7 ...	157·0
(*f*) Femur, Tibia	161·7 ...	157·0
(*g*) Humerus + Radius	162·4 ...	159·8
(*h*) Humerus, Radius	159·7 ...	155·5
(*i*) Femur, Humerus	159·6 ...	156·0
(*k*) Femur, Tibia, Radius, Humerus	158·3 ...	154·5

Now my experience of reconstruction shows me that with primitive races we do not get from formulæ based on modern data very consistent results when the radius is used.[1] I believe (*a*), (*f*) and (*i*) are the best formulæ to take in such cases. Effecting a perhaps not wholly defensible smoothing by taking means we have:—

Stature of Lansing individual	If ♂	If ♀
From all formulæ	161·3 ...	157·3
From (*a*), (*f*) and (*i*)	161·2 ...	156·5

The mean deviation of all the formulæ from the mean of the set is on the assumption that the bones belonged to a man 1·91, and on the assumption that they belonged to a woman 2·02. Thus the formulæ run from both aspects slightly more smoothly if we assume the bones to be those of a man. The skull may possibly offer, on closer study, some balance of characters on which to form an appreciation as to sex. Prof. Williston's photographs, having regard to the lower mandible and brows, do not seem wholly inconsistent with the male sex.

As to the date of the Lansing bones, this can only be settled by the geologists on the spot. But if the period be at all comparable with that of Palæolithic man in Europe, of whom, I think, we may put the best available estimate of stature to be 162·7 cm., the American and European statures, so far as such slender evidence goes, are not widely apart. If, on the other hand, we take the bones to be those of a woman, the stature of 157·3 cm. would correspond to a male stature of 169·0 cm.—a value considerably above that of Palæolithic man in Europe, or, indeed, of Neolithic man.

Hence I would suggest the following points for consideration:—

A. *The bones are those of a man.*

If they belong to those of an "early" American man,

(*a*) He was, if a normal example, of much the stature of Palæolithic man in Europe.

(*b*) He must have been a short man for his race, if early American man was much taller than the European Palæolithic man.

B. *The bones are those of a woman.*

If they belong to those of an "early" American woman,

(*a*) The early Americans, if she were a normal example of a woman, had a male stature of 169 cm., and were a taller race than early European man.

(*b*) She must have been a tall woman for her race, if early European and American men were at all similar in stature.

The stature of the American Indian is very considerable; if, therefore, a great antiquity can be predicted, *i.e.* if the silt would seem to show that the bones have been many thousand years embedded, the importance of determining the sex becomes obvious. No dogmatic statement, remembering the variability of human stature, can be made, but the find gives a *slight* probability in favour of American early man and European Palæolithic man not diverging widely in stature, if the bones are male, but, on the other hand, if the bones are female, they give a *slight* probability in favour of American early man being much taller than European Palæolithic man.

It is easy to make irresponsible suggestions at a distance, but is it not possible for a systematic investigation to be made by excavating the whole, or a large part, of the deposit upon the limestone bed at Concannon's house, with the hope of discovering further human remains, or signs of human handicraft?

KARL PEARSON.

[1] Everything tends to show a shortening of the radius relative to the length of the other long bones, since early times.

Reform in School Geometry.

THE reviews in your issue of April 23 tend to confirm an apprehension I have long felt. Euclid is to be abolished, and another sequence of propositions substituted. But it is probable that in many cases the same old methods of teaching will be retained, the same old drudgery of learning propositions and not learning to think, will be gone through by the future generation as it has been gone through by the past. The only difference will be that the one redeeming feature of the old system, the semblance of a logical sequence, will be abolished, and students will be commended instead of condemned for assuming constructions before they have learnt how to perform them. They will also be encouraged to base their proofs on such difficult-to-be-understood concepts as *direction*.

Now it appears to me that instead of the new geometry being a recent innovation, its essential features are pretty well laid down in the "Treatise on Geometry" published in 1871 by the late Dr. Watson (Longmans' Text-books of Science). The disadvantages of Euclid's order of treatment, the use of hypothetical constructions, the importance of loci, the classification of propositions, all these and many other points on which stress is now laid are discussed in Dr. Watson's preface. Whether or not would-be reformers of mathematical teaching have studied Watson, it is interesting to find the supposed "modern up-to-date improvements" in the teaching of geometry so closely forestalled in a book of thirty years ago, just as the so-called "modern free wheel" was commonly fitted to tricycles from 1879 onwards, until cyclists were glad when a substitute was invented.

G. H. BRYAN.

I WILL not deny that some reformers desire to abolish Euclid and establish another sequence of propositions in abstract geometry for schoolboys; but if Prof. Bryan reads the reviews which he cites more carefully, he will see that the reform current is very strong in quite another direction, and that his long-held apprehension is altogether baseless. I think that I apprehend the idea underlying the efforts of the majority of the reformers. It is the very old idea that the average English boy may be educated through the doing of things rather than through abstract reasoning. If abstract geometry is to be retained as a school subject, it can only in the future, as in the past, do harm to 98 per cent. of the boys; we say, drop it altogether in schools, and think of it only in connection with the universities. Two per cent. of schoolboys take to abstract reasoning as ducks take to water, and they ought not to be discouraged from the study of Euclid, but they and all the other boys ought to study geometry experimentally, logic entering into the study just as it enters into other parts of experimental physics. If the best modern books have a fault, it lies in the absurd assumption that an experimental sequence ought to have some connection with the Euclidean sequence.

JOHN PERRY.

Can Dogs Reason?

MY account of an experiment which you allowed me to record in NATURE of April 16 has been copied into a number of newspapers, and has brought me no few letters. Some of my correspondents explain the negative results of the box-meat experiment by supposing that the dog was too well trained to "steal" the meat. They have not noticed that I was careful to point out that the box was placed in the yard in which the dog is accustomed to be fed, that

he was very eager to get the meat out of it, and that when later in the day he succeeded, he showed no manner of misgiving as to his legal right to its possession.

Other of my correspondents misunderstand the purpose of the experiment. They see in it a desire to belittle their canine pets. This was very far from my thoughts. We have innumerable anecdotes telling us what dogs can do. I wish, partly I admit with a view to enabling us to sort these stories, to obtain, as data, definite observations showing what dogs will not do. Into most dog stories there creeps the little touch of human nature which makes them and ourselves akin.

Mine is the point of view of an anatomist. A dog has a brain very different from that of man. Brain and mind are the two sides of the same coin; or rather, brain is the coin, mind its value. The dog's brain cannot make a man's thoughts. How near can we come to picturing to ourselves the nature of a dog's thoughts? Without committing ourselves to Flechsig's theory of the division of the cortex of the brain into "projection areas" and "association areas," we may on anatomical grounds assert that the cortex of a dog's brain contains fewer association elements than does that of a man. It is an apparatus for transforming sensory impressions into actions, in a more limited and exclusive degree. Probably we can best picture to ourselves the work that it does by supposing that the wordless thoughts of animals are direct combinations of sensory impressions; whereas man has invented symbols for his sensory impressions. He works the symbols into thought. Nor do his symbols stand for material objects alone. They also stand for inferences from observations. But this is a subject which perhaps I ought not to touch without having at my disposal more space than I can ask you to give me in your Journal.

We must admit with Sir William Ramsay that dogs make use, in their mental operations, of sensory impressions and not of inferences, although I dissent from his qualification of their impressions of smell as "vague." It is my object to ascertain, by means, if possible, of observations which can be made under properly controlled conditions upon numerous dogs of various breeds, the limits of their power of substituting inferences for sensory impressions as materials of thought.

Perhaps I may be allowed to use a new nomenclature in defining the position in which, as it appears to me, we stand with regard to the axioms of animal psychology at the present time. An animal remembers. When it performs an action a picture of the action is stored in memory. If the result of the action be satisfactory, a picture of this result is stored in memory. When in future the animal desires to obtain the result it repeats the action. This we may call the product of "reasoning in the first degree." Action depends upon inference. We may accept it as an axiom that an animal can draw an inference of this kind. It is not yet established, by experimental methods, that an animal can combine two inferences, or, as I venture to term it, "reason in the second degree." My box-experiment was intended to throw light upon this question. I shall be very grateful for any further suggestions of possible experiments of the same kind.

ALEX. HILL.

Downing Lodge, May 2.

Spherical Aberration of the Eye.

WITH reference to the experiment described by Mr. E. Edser (p. 559) as appearing to have "escaped observation," perhaps I may be allowed to state that this phenomenon was (to the best of my recollection) described by me before the School Natural History Society when I was a boy at Rugby, about 1873–1874. I could not explain it, and no one at the meeting had any suggestion to make.

I think I connected it in my mind with irradiation phenomena, though I was baffled by the fact that the *whole* line is bent.

If the black horizontal lines drawn between different advertisements on the outside of NATURE be held five or six inches from the eye, and the rounded end of a pen be brought down close to the eye, the whole line will be seen to curve upward to meet the pen, becoming also blacker and more distinct.

W. L.

THE phenomenon mentioned by W. L. must have frequently been noticed; while resembling that described by me as a proof of the spherical aberration of the eye, it is yet due to an essentially different cause. The black line, when placed at a distance of five or six inches from the eye, is within the shortest distance of distinct vision from the latter. A point source of light, situated on the axis of the eye, at a position closer to the eye than the "near point," produces a relatively large spot of light on the retina. If the pupil be now progressively covered from above, the rays passing through the middle and upper part of the pupil will be cut off, so that those passing through the lower part of the pupil alone remain; these cut the retina in a comparatively restricted area below the point of intersection by the axis of the eye, so that the image apparently rises, at the same time becoming more sharply defined. Under the conditions mentioned, the same phenomenon would be observed if the eye were entirely free from spherical aberration. For this reason I stated that the black band should be placed "just beyond the shortest distance of distinct vision from the eye; . . . care must be taken to keep the eye carefully focused on the edge of the black band, or an exaggerated displacement, due to relaxation of the accommodation of the eye, may result." It was merely as a proof of the spherical aberration of the eye that I described this experiment as having apparently escaped observation.

April 12. EDWIN EDSER.

IN connection with the experiment on the spherical aberration of the eye, described in your issue of April 16, I may relate a striking observation I made some years ago. Regard with one eye any light or bright object on the wall, turn the head away until the object is just covered by the line of the nose; then move the eye to its natural position, and the object will reappear, supposing the nose is not too prominent. Moving the eye several times to and fro, the phenomenon will be easily observed.

Leipzig, April 29. W. BETZ.

THE SOLAR AND METEOROLOGICAL CYCLE OF THIRTY-FIVE YEARS.

THE fact that the rainfall of many regions of the earth's surface has, for the last decade or more, been gradually diminishing has led many inquiries to be made concerning the possible periodicity of this meteorological element, and during the last few months more general attention has been drawn to this interesting question. The great importance of this inquiry, not only to agriculturists but to others, renders it desirable that all facts which may tend to elucidate the subject should be thoroughly discussed.

The object of the present article is to bring together, without entering into too great detail, a few statistics relating to the rainfall of different stations in various parts of the earth to see whether there be grounds for assuming a continuation of the present small supply, or whether a greater abundance may be looked for with special reference to the condition of the British Isles.

A few introductory remarks may here not be out of place. Eduard Brückner first discovered that wet periods, great droughts, &c., occurred at intervals of about thirty-five years, and he published his important conclusions in a volume which was, and still is, a valuable contribution to meteorological science. To take one element only, namely, rainfall, Brückner showed that during the last century the mean epochs of the wet years were 1815, 1846–50, and 1876–80, while those for the dry years were 1831–35 and 1861–65.

Since the publication of this volume, many workers have studied rainfall and other records extending over long periods of time. Thus, to take one instance among many that might be cited, Herr Hofrath Julius Hann, the distinguished late director of the Vienna Meteorological Institute, made a minute investigation of the

rainfalls of Mailand, Padua, and Klagenfurt, and found a well-marked recurrence of the wet and dry periods every thirty-five years, the mean epochs of the former being 1808, 1843, and 1878, and of the latter 1823, 1859, and 1893.

In determining the variation of rainfall over such long periods as that of thirty-five years, it is necessary, if possible, to smooth the curve representing the variation from year to year, for this curve, as a rule, displays large fluctuations from the normal in the course of a very few years, and it is not easy for the eye to grasp the longer periods of variation; these long periods may to some extent be rendered more apparent by coupling up together the mean values of the rainfall for several years, and forming another mean, but somewhat fictitious value, for each successive year. Thus, for instance, the mean for one year, say 1870, might be computed from the means of the five years 1868 to 1872, or the means for 1871 from the mean of the years 1869 to 1873; instead of a five-year mean, a ten-year or a fifteen-year might be chosen.

In the figure here given, five-year means have been adopted, and the curves resulting from these have been further smoothed by drawing freehand another curve to eliminate as far as possible the smaller fluctuations of short period that still exist, even after still minor changes have been eliminated. The stations, the rainfall curves of which are here given, have not been specially selected, but simply taken as the data for them were easily available, and they afforded long records for the study of such variations as are here discussed. The short curve for the British Isles is attached so that not only can a comparison be made of this record of the Meteorological Office with that obtained by the late Mr. Symons, but that the actual variation over the islands taken together can be compared with two widely separated stations in them, as Greenwich and Rothesay. The European continent is here represented by Brussels, the epochs of the maxima and minima of the rainfall curve of which can be compared with the values given by Hann and referred to in a previous paragraph.

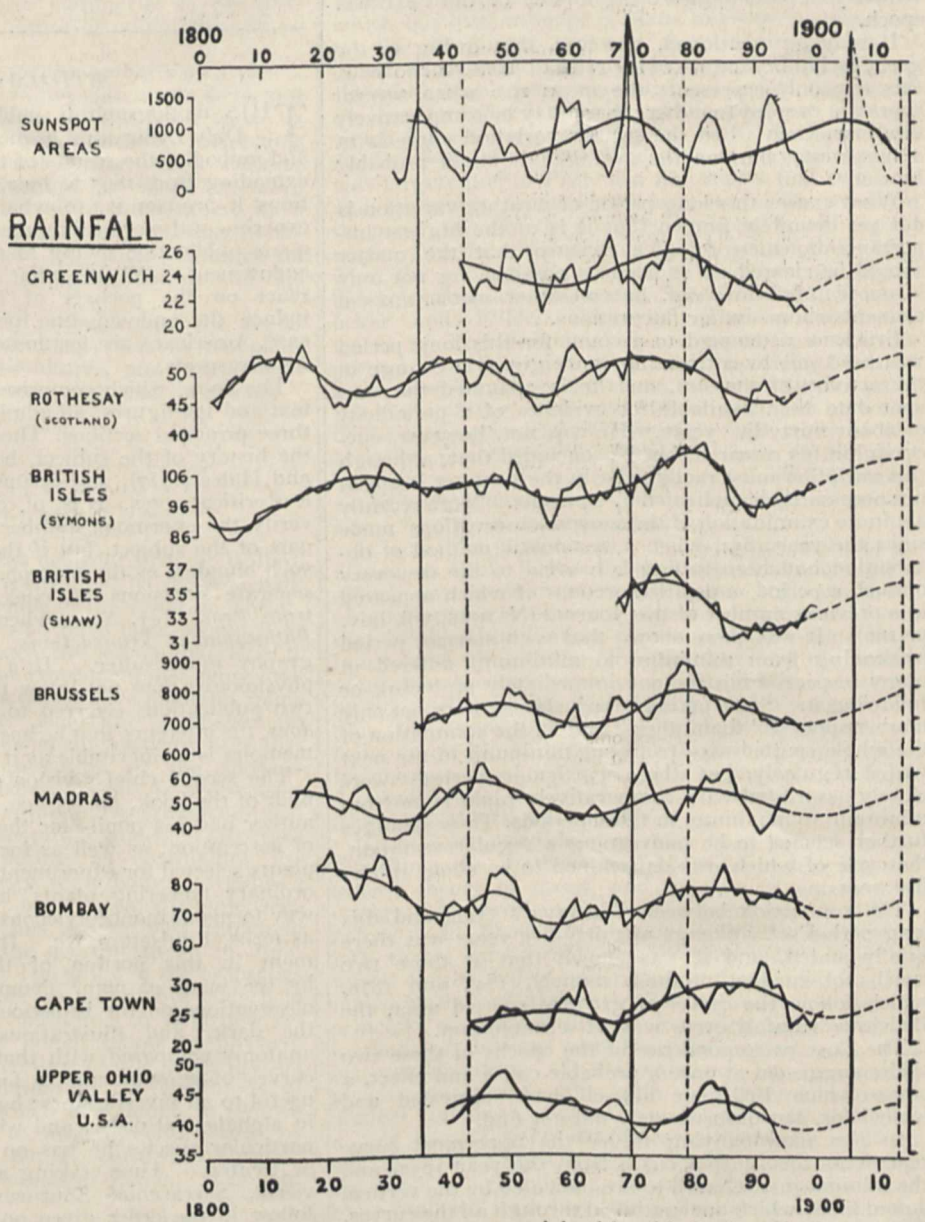

FIG. 1.—Curves showing the relation between the 35-year sunspot period and that of the Brückner rainfall cycle. Each of the rainfall curves is determined from the means of five-years, and these curves are smoothed by freehand drawing in order to show the long period variation of rainfall. The smoothed curve through the eleven-year sunspot curves indicates the epochs of the long period sunspot variation.

Two stations in India, Bombay and Madras, one station in South Africa, Cape Town Observatory, and lastly three stations in the United States of America representing the rainfall of the Upper Ohio Valley, complete the rainfall information here given.

A general collective glance at these curves shows that there is an undoubted long period variation in all the stations here brought together. Further, that the periods of greatest rainfall occur *generally* in the years 1815, 1845, and 1878–83, while those at which the rainfall is decidedly deficient are about the years 1825–30, 1860, and 1893–5.

With the existence of these very definite fluctuations it is important to notice that the last minimum or dry period which is most apparent in the case of the curves representing the British rainfall seems now to be just

past, or on the point of coming to a conclusion, and in all cases the general tendency of the long period curve is now to rise again. This indication of the increase of the rainfall is represented in the figure by the dotted continuation of the secular variation curves for each station, and should the apparent law hold good, there seems sufficient evidence to mark that this rise will continue to take place until about the year 1913, which year will suggest the middle of the next wet epoch.

It may be mentioned, however, that owing to the great oscillatory nature of the rainfall from year to year, this rise only represents the mean rise when several years are coupled together; there may be comparatively dry years even when the secular variation curve is at a maximum, but on the average they will probably be wet.

What causes this long period of weather variation is not yet definitely known, but it is of the highest importance to meteorological science that the matter should be cleared up as soon as possible, for not only is our rainfall involved, but all other meteorological elements show similar fluctuations.

Brückner attempted to account for this long period weather cycle by attributing its origin to a change in the activity of the sun, and he investigated the sunspot data then available for evidence of a periodicity of about thirty-five years. He was not, however, successful in his research, but he concluded that, although this variation must really exist in the sun, yet it might not necessarily be indicated by sunspots. More recently a minute examination of the sunspot observations made since the year 1832, when a systematic method of observation had been initiated, has led to the discovery of such a period, a detailed account of which appeared in a previous number of this Journal (NATURE, vol. lxiv. p. 196). It was there shown that each sunspot period (reckoning from minimum to minimum) differed in many respects from the one immediately preceding or following it. Some periods, for instance, were not only more "spotted" than others, that is, the summation of the whole spotted area from one minimum to the next varied regularly, but these particular periods were closely associated with comparatively rapid rises from minimum to maximum in those periods. These changes further seemed to be undergoing a regular variation, the cycle of which was determined to be about thirty-five years.

The connection between Brückner's cycle and this long period solar change of thirty-five years was there briefly stated, and it was shown that at those two epochs of sunspot minima, namely, 1843 and 1878, which follow the cycles of greatest spotted area, the Brückner rainfall cycle was at a maximum.

The close correspondence of the epochs of these two cycles suggested at once a probable cause and effect, a cause which Brückner himself had suggested and looked for, but unfortunately did not find.

In the accompanying figure the uppermost curve represents the sunspot curve from the year 1832, and the minima just referred to are indicated by the vertical dotted lines, which are continued through all the curves. The periods of greatest spotted area just precede these epochs, and the times of maxima are shown by the vertical continuous lines drawn in a similar manner. To show the probable times of the recurrence of these epochs during a portion of the next great period of thirty-five years two vertical lines have been inserted at the years 1905, which is the probable epoch of the next great maximum, and 1913, the following minimum, so that their relation to the probable variation of rainfall, as indicated by the dotted portions of the curves, can be seen at a glance.

In conclusion, attention may be drawn to the fact that during the last few years a far more close connection between solar and meteorological phenomena has been made out than was the case some years ago, and since this long period rainfall cycle synchronises so well with the solar changes, the latter may render valuable assistance in determining the epochs of these dry and wet cycles. WILLIAM J. S. LOCKYER.

ETIOLATION.[1]

THIS monograph is published by the aid of the Daly Lydig fund bequeathed by Charles P. Daly, and embodies the results of the author's investigations extending from 1895 to 1902, and one of the first questions it arouses is, to what extent is this sustained experimental work stimulated by the certainty of adequate publication owing to the generosity of patriotic endowment, and to what extent does such work react on the pockets of friendly millionaires and induce the endowments for further work? In any case, Americans are fortunate in their circumstances in these respects.

The book, which comprises more than 309 pages of text and 176 figures, all admirably done, is divided into three principal sections. There is, first, a summary of the history of the subject, beginning with Ray (1686) and Hales (1727), and occupying 34 pages of more or less critical notes. It is, of course, impossible for us to verify the enormous number of the references to this part of the subject, but if the author has made many such blunders as those on pp. 27 and 29, where on two separate occasions he cites volumes and pages as from *Proc. Roy. Soc.* when he should have written *Philosophical Transactions*, the value of his bibliography must suffer. If a leading American plant physiologist does not know the difference between the two publications referred to, it is time he did; if he *does*, the inference that he has not consulted the original memoirs is as inevitable as it is dispiriting.

The second chief division of the work occupies the bulk of the book, pp. 35–200, and reflects credit on the author and his pupils for their industry and clearness of description, as well as for the interesting choice of plants selected for experiment. These include not only ordinary flowering plants, but also more out of the way forms of monocotyledons and dicotyledons, as well as ferns, Equisetum, &c. The one note of disappointment in this portion of the book will be struck by the want of plan. Numbers of most interesting observations on the behaviour of particular species in the dark, and illustrations of their facies, their anatomy compared with that of normal plants, their curves of growth and so forth will make the book useful to all investigators; but the plants are arranged in alphabetical order, and when the reader turns to a particular species he has no guide as to how it will be treated. Thus, taking at random Salvia, Sansevieria, Sarracenia, Saururus, and Sparaxis, which follow in the order given on pp. 171–180. The first merely heads a small paragraph stating that the corolla is atrophied in darkness. Under Sansevieria the etiolation of the shoot is described only in so far as external changes are concerned. In Sarracenia the effects of etiolation on the histology of the epidermis lining the "pitchers" are well illustrated. In Saururus figures of the anatomy of etiolated and normal stems, and measurements of height and thick-

1 "The Influence of Light and Darkness upon Growth and Development." By D. T. Macdougal, Ph.D., Mem. New York Bot. Garden. Vol. ii. Pp. xiii + 319. (1903.)

ness form the theme; while Sparaxis heads a short paragraph recording failure of growth.

All this suggests a heterogeneous collection of student's notes as the groundwork of the memoir, and interesting and useful as many of these are, they might have been rendered more valuable by classification and efficient editing.

The third portion of the book is occupied with general considerations, and embraces summaries of the foregoing, theories as to the nature of etiolation, and so forth.

Here, of course, we look for the author's own views, but with the exception of vague statements here and there, the concluding portions of the book force us reluctantly to decide that, important and interesting as the memoir is, it is so not so much as a work of original thought and suggestion, but as an extensive and more or less critical survey of what others have done. In this category it stands well, and may be recommended, but we do not like such sentences as the following exercise for the grammarian and the physicist:—

"It is, of course, entirely probable that the action of light may set up chemical processes in the plant is in a manner entirely stimulative, and independent of any communication or transformation of energy" (p. 201).

PROF. J. WILLARD GIBBS.

THE announcement of the death of Prof. J. Willard Gibbs, of Yale University, will be received with the deepest regret by the whole of the scientific world.

There are few workers who have done so much as Prof. Willard Gibbs to teach the lesson that it is to the mathematician that the experimentalist must look for new ideas. The papers which have made his name famous date from 1873, when he published in the *Transactions* of the Connecticut Academy his paper on the geometrical representation of the thermodynamical properties of bodies. Gibbs first discussed the advantages of using different thermodynamical variables for graphic representation, and then discussed the surface formed by taking as coordinates the volume, entropy and energy of a body. "Gibbs's thermodynamical model," or "thermodynamic surface" as it is now called, has become best known to English readers through the account given in Maxwell's "Theory of Heat." The study of the properties of thermodynamical surfaces has afforded a wide field of research, which is still continuing to yield new results in the hands of the Dutch school of physico-chemists. A remarkable feature of the investigation is the geometric representation of the conditions of thermodynamic stability, which does much to remove the difficulties attaching to any algebraic form of enunciation. A further paper, entitled "Graphic Methods in the Thermodynamics of Fluids," was published in 1878.

Gibbs's epoch-making papers *par excellence* are, however, those dealing with the equilibrium of heterogeneous systems, the first of which, dealing with chemical phenomena, was published in June, 1876, while the second, dealing with capillarity and electricity, appeared in July, 1878. The most essential feature of Gibbs's discoveries consists in the extension of the notion of the thermodynamical potential to mixtures consisting of a number of different components, and the establishment of the properties that this potential is a linear function of certain quantities which Gibbs has called the potentials of the components, and that where the same component is present in different phases which remain in equilibrium with each other, its potential is the same in all the phases, besides which the pressures and temperatures of the phases are equal.

The importance of these results was not realised for a considerable time. It was difficult for the experimentalist to appreciate a memoir in which the treatment is highly mathematical and theoretical, and in which but little attempt is made to reduce conclusions to the language of the chemist; moreover, it is not unnatural to find the pioneer dwelling at considerable length on comparatively infertile regions of the newly-explored territory, while points of vantage which have subsequently proved to be the most productive fields of study were dismissed very briefly. It was largely due to Prof. van der Waals that two new and important fundamental laws were discovered in the paper, namely, the phase rule and the law of critical states, and the consequences of the first of these laws were the subject of remarkable developments in the hands of Bakhuis Roozboom, Schreinmakers, Stortenbeker and Wilder Bancroft. The well-cultivated tracts of knowledge which represent a most important branch of modern physical chemistry bear but little resemblance to the crude, often circuitous path, full of stumbling blocks and difficult obstacles by which Gibbs first opened up this region. The study of dissociation phenomena has afforded some of the most beautiful experimental verifications of Gibbs's theories, which have done much to convert theoretical chemistry into a branch of applied mathematics.

It is not the physicist and chemist alone who are indebted to Prof. Gibbs; he has also made his mark among mathematicians in connection with the study of quaternions and vector algebra. Physicists claim that in the Hamiltonian system of quaternions there is a loss of naturalness from the fact that the square of a vector becomes negative. Gibbs met the objection by suggesting an algebra of vectors with a new notation, the expression for the product of two vectors being formed in such a way as to give a positive value for the square of a vector. His paper on "Multiple Algebra" was published in the *Proceedings* of the American Association for 1886.

Gibbs's attention has recently been turned to remodelling the mathematical theories underlying the kinetic theory of gases, and the law of partition of energy. His work on statistical mechanics has been before us for about a year, but so difficult is the subject that a considerable further time must elapse before it can be widely understood and appreciated. His interpretation of the determinantal equation as the principle of conservation of extension in phase, his methods of dealing with ensembles of systems, and his establishment of the existence of irreversible phenomena in connection with such ensembles are all distinct advances, but in connection with the last-named properties an idea necessarily forces itself on one that there must be some assumption underlying the proof which might with advantage be discussed more explicitly than was done in the treatise in question, and his loss at the present time deprives us of the prospect of further enlightenment on difficulties which no amount of mere mathematical formulæ will clear up.

As mentioned last week, he was elected Foreign Member of the Royal Society in 1897, and received the Copley medal in 1901. He was also an honorary or corresponding member of the British Association, the Cambridge Philosophical Society, and many other learned societies both in this country and abroad.

G. H. B.

NOTES.

THE annual conversazione of the Royal Society will be held on Friday, May 15.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the Society:—Dr. W. M. Bayliss, Prof. T. W. Bridge, Dr. S. Monckton Copeman, Mr. Horace Darwin, Mr. W. P. Hiern, Mr. H. R. A. Mallock, Prof. D. Orme Masson, Mr. Arthur G. Perkin, Prof. E. Rutherford, Prof. R. A. Sampson, Mr. J. E. Stead, Mr. A. Strahan, Prof. J. Symington, Prof. J. S. Townsend, and Mr. A. N. Whitehead.

AT the annual general meeting of the Institution of Civil Engineers, held on April 29, Sir William H. White, K.C.B., F.R.S., was elected president for the sessional year 1903–1904.

DR. P. CHALMERS MITCHELL has been elected secretary of the Zoological Society in the place of Mr. W. L. Sclater, who held the office as acting secretary since the retirement of his father, Dr. P. L. Sclater, F.R.S., last year.

FURTHER particulars of the work and position of the National Antarctic Expedition have been brought by the New Zealand mail, and are published in Wednesday's *Times*. The chief scientific work accomplished by the expedition is summarised as follows:—(1) The discovery of extensive land at the east extremity of the great ice barrier. (2) The discovery that MacMurdo Bay is not a "bay," but a strait, and that Mounts Erebus and Terror form part of a comparatively small island. (3) The discovery of good winter quarters in a high latitude—viz. 77° 50′ S., 166° 42′ E.—with land close by suitable for the erection of the magnetic observatories, &c. The lowest temperature experienced was 92° of frost Fahrenheit. (4) An immense amount of scientific work over twelve months in winter quarters, principally physical and biological. (5) Numerous and extensive sledge journeys in the spring and summer, covering a good many thousand miles, of which the principal is Captain Scott's journey, upon which a latitude of 82° 17′ south was attained, and an immense tract of new land discovered and charted as far as 83° 30′ south, with peaks and ranges of mountains as high as 14,000 feet. (6) The great continental inland ice reached westwards at a considerable distance from the coast and at an altitude of 9000 feet. (7) A considerable amount of magnetic work at sea, also soundings, deep-sea dredging, &c. Commander Scott's narrative of the expedition and statement of scientific observations, telegraphed from Lyttelton, and given in our issue of April 2 (p. 516), is thus confirmed. It was not clear at the time of the cable message why the *Discovery* could not get out of the ice, though the relief vessel, the *Morning*, had done so and returned to New Zealand. It is now known, however, that the *Morning* only got within about eight miles of the *Discovery*, and the stores had to be transferred by means of sledges. As the *Discovery* has not returned to Lyttelton, there is little doubt that the expedition has been forced to spend a third winter in the Antarctic. Much additional expense will thus be incurred, and it is estimated that from 12,000*l*. to 20,000*l*. more will be needed to meet it.

THE death is announced of Mr. C. Bartlett, late superintendent of the Zoological Society.

A UNIVERSAL Exposition of Sciences, Arts, and Industries is to be held at Liége in the year 1905.

THE death is announced of M. de Bussy, member of the Institute of France, and well known as a naval engineer.

AN earthquake shock, lasting five seconds, was felt in villages between Worksworth and Derby on Sunday, May 3, at 9.20 p.m.

ACCORDING to a Central News message from San Francisco, dated May 1, a report from San Juan states that the Santa Maria volcano in Guatemala is in a state of active eruption.

THE Louis Pillet prize of the Chemical Society of Paris has been awarded to M. E. Theulier, director of the technical staff and head of the research laboratory of Messrs. Lautier fils, of Grasse.

AN international exhibition of agriculture and horticulture, which the Cercle grand-ducal d'Agriculture et d'Horticulture du Grand-Duché de Luxemburg is organising at Luxemburg on the occasion of the fiftieth anniversary of its foundation, will be held from August 29 to September 7.

IT is announced in *Science* that the Donohoe comet-medals of the Astronomical Society of the Pacific have been awarded to M. Michel Giacobini, of Nice, for his discoveries of unexpected comets on December 2, 1902, and January 15, 1903.

THE proposed electric railway to the summit of Mont Blanc is to be commenced shortly. The municipal authorities of Saint Gervais-les-Bains have accepted the scheme, and have accorded the concession to the French engineers, MM. Deruad and Duportal.

A NOTEWORTHY point in connection with the illuminations of Paris, organised by the reception committee in honour of the King's visit, was the electric incandescent lamps of different colours in the chief streets and avenues and on many large buildings. The effect was very brilliant, and the large crowd of sightseers admired it exceedingly.

THE council of the Society of Arts is prepared to award, under the terms of the Benjamin Shaw Trust, a prize of a gold medal, or twenty pounds, for the best dust-arresting respirator for use in dusty processes and in dangerous trades. Inventors intending to compete should send in specimens of their inventions not later than December 31 to the secretary of the Society of Arts, John Street, Adelphi, London, W.C.

INVITATION cards in the name of the president of the Institution of Electrical Engineers are being issued to members of the Institution for a concert to be given at the Royal Albert Hall on the evening of Thursday, June 11, on the occasion of the International Telegraph Conference. The annual conversazione of the Institution will be held at the Natural History Museum on the evening of Tuesday, June 23. This date has been selected as one on which it will be possible for the members of the International Telegraph Conference to be present.

ON Tuesday next, May 12, Prof. G. H. Darwin delivers the first of two lectures at the Royal Institution on "The Astronomical Influence of the Tides," and on Thursday, May 14, Prof. S. H. Vines begins a course of two lectures on "Proteid-Digestion in Plants." The Friday evening discourse on May 15 will be delivered by Dr. D. H. Scott on the "Origin of Seed Bearing Plants."

THE new Johnston Laboratory at University College, Liverpool, is to be opened by Mr. Walter Long, M.P., President of the Local Government Board, on Saturday, May 9. Many distinguished men of science have expressed their intention to be present at the ceremony. On Monday, May 11, a conference on tropical sanitation will be held in the college.

THE Manchester Literary and Philosophical Society will shortly celebrate the centenary of Dalton's enunciation of the atomic theory. On May 19 Prof. F. W. Clarke, of the Columbia University, Washington, will deliver a lecture on the evolution and philosophy of the theory. Arrangements are also being made for a conversazione at Owens College, and exhibition of Dalton manuscripts, portraits, and other records.

REUTER reports that if within a short time no ship from the Falkland Islands arrives at Montevideo or Buenos Ayres with news of the Nordenskjöld Antarctic expedition, an expedition to relieve Nordenskjöld will be equipped at Stockholm immediately, and should no intelligence of the explorer have come to hand in the meantime, will leave on September 1 for the South Shetland Islands, where it should arrive about the middle of November. The funds required for the relief expedition have already been secured.

A GREAT rock slide occurred on the morning of April 29 at Frank, a small mining town on the Canadian Pacific Railway in the Rocky Mountains, and in Alberta Territory. A telegram from Sir Wilfrid Laurier states that the whole east end of Turtle Mountain from the mouth of Frank Mine slid into the valley and blocked it entirely. The railway was covered with débris for a mile and a half east of Frank. The landslip gave rise to great clouds of dust, which were at first thought to be due to a volcanic eruption, and was reported as such, but this conclusion was entirely unfounded.

CAPTAIN SVERDRUP gave an account of his expedition to the Arctic region in 1898 to 1902 before the Royal Scottish Geographical Society on Monday night, and was presented with the gold medal of the Society in recognition of his achievements. Sheriff Guthrie, who presided, prefaced the address with an appeal on behalf of the Scottish Antarctic expedition under Mr. W. S. Bruce. The leader hoped to be engaged in his work for two years, and funds for the first year are still short by 2250*l.*, while for the whole expedition a sum of 10,000*l.* is wanted.

THE Government of India is endeavouring to bring into being the Tata institution for scientific teaching and research at Bangalore. The *Daily Mail* states that the Government has just addressed the Bombay Administration, offering to increase the grant so as to raise the total annual income of the institute to 15,000*l.*, conditionally on the Mysore durbars carrying out its proposal that they should assist. Lord Curzon hopes that Mr. Tata will now expedite his arrangements so as to enable legislation for the constitution of the institute to proceed.

IN the article on standardisation which appeared in NATURE of April 23 (p. 587), it is stated that the work of the Engineering Standards Committee was started two years ago at the suggestion of the Institution of Mechanical Engineers. Mr. Leslie S. Robertson, the secretary of the committee, writes to point out that the committee was formed in pursuance of a resolution of the council of the Institution of *Civil* Engineers. We are glad to make this correction, both for the sake of historical accuracy and because the fact was well known to the writer of the article, who inadvertently named the wrong institution.

M. E. DUPORCQ (Ingénieur des télégraphes), whose death was announced recently (p. 589), was general secretary of the Mathematical Congress at Paris in 1900, and worked hard to make it a success. He was also a vice-secretary of the Mathematical Society of France, and editor of the *Nouvelles Annales*, where most of his mathematical contributions are to be found. These were chiefly in the region of elementary pure mathematics, and he was also a deviser of mathematical problems of the style of Prof. Wolstenholme.

PROF. GEORGE E. HALE has informed *Science* that Miss Helen E. Snow, of Chicago, has provided for the reconstruction of the cœlostat reflecting telescope of the Yerkes Observatory as a memorial to her father. The telescope will be provided with solar and stellar spectrographs, spectroheliographs and other important accessories. The cœlostat reflector which the new telescope is to replace was seriously injured by fire last December, giving rise to erroneous but widespread statements that the main building of the Yerkes Observatory, as well as the 40-inch refractor, had been destroyed.

WE are requested to announce that a representative committee has been formed for the purpose of raising a memorial to the late Sir Henry Bessemer. The remarkable industrial development of the world in recent years is largely due to the metallurgical process which bears the name of Bessemer, and it has long been felt that his life's work should be suitably commemorated in the centre of the British Empire. The objects of the memorial are, first, the erection (and, if necessary, the endowment) of metallurgical teaching and research works in connection with the University of London, equipped for the testing of ores and metallurgical products by modern methods, and for the investigation of new methods and processes; and, second, the foundation of international scholarships for post-graduate courses in practical work in connection with proposals now under the consideration of the Board of Education. The committee is thoroughly representative, and among the men of science upon it are Sir William Abney, K.C.B., F.R.S., Sir John Wolfe Barry, K.C.B., F.R.S., Dr. C. Le Neve Foster, F.R.S., Prof. A. K. Huntingdon, Sir Arthur Rücker, F.R.S., and Sir H. Trueman Wood. A meeting to inaugurate the fund will be held at the Mansion House on Monday, June 29 next, particulars of which will be published later. All communications should be addressed to the secretary, Mr. Charles McDermid, Bessemer Memorial Fund, Salisbury House, London, E.C.

BY the death of Mr. Osler, which occurred on April 26 at his residence, South Bank, Edgbaston, Birmingham, at the age of ninety-five, meteorological science has lost another of its distinguished pioneers. His principal works in this science were contributed to the *Proceedings* of the British Association, and to the *Proceedings* of the Literary and Philosophical Society of Birmingham, between the years 1836 and 1858. He was perhaps best known by his invention of a self-recording direction and pressure anemometer and rain-gauge; one of these instruments was erected at the Philosophical Institute at Birmingham, and a discussion of the observations obtained by it during the years 1839 and 1840 was published in the *Proceedings* of the British Association. Another instrument was erected at the Liverpool Observatory in 1851, and a summary of the records for 1852–5 was published in the latter year. From a report recently received from that observatory, we find that his combined anemometer and rain-gauge is still in use, and continues to give entire satisfaction. In recognition of his researches in this branch of science he was elected a fellow of the Royal Society in 1855. In his earlier years he was actively engaged in the development of the glass industry in Birmingham.

M. PAUL DU CHAILLU, the African explorer and discoverer of the gorilla, died at St. Petersburg on April 30. Paul

Belloni du Chaillu was born in 1835, and at an early age he went to live in the French colony of Senegambia, where his father was a trader. There he acquired a knowledge of languages and modes of life of the tribes, devoting much attention to natural history. At the age of seventeen he went to the United States, where he naturalised himself, but in 1855 he sailed for West Africa again, and spent four years in the interior unaccompanied by any white men, traversing a distance of more than 8000 miles on foot in the equatorial region. The results were embodied in the most important of his works, "Explorations and Adventures in Equatorial Africa" (1861). He returned also with many specimens, some of which were acquired by the British Museum. The work provoked much controversy, and his gorilla and cannibal stories, in particular, were widely discredited; but the general truth of his narrative was afterwards substantiated, both as regards the river systems of the Continent, its equatorial population, and its zoological characteristics. In 1862–65 Du Chaillu revisited West Africa, and afterwards published an account of the expedition in a volume under the title of "A Journey to Ashango-land" (1867). Since then he had made journeys in Sweden, Lapland, and Finland, and written numerous works, the chief being "Stories of the Gorilla Country," "Wild Life under the Equator," "Lost in the Jungle," "The Country of the Dwarfs," "The Land of the Midnight Sun," and "The Age of the Vikings," in which he contended that the origin of the English race was Scandinavian. He was also the author of other works.

REFERRING to Mr. G. Henschel's letter in last week's NATURE (p. 610) on complementary singing by bullfinch and canary, Mr. J. R. Paul writes from Alcluith, Dumbarton, to say that he put a red-pole in a cage hung between the cages of two canaries. After a time the bird dropped the brisk "tweet, tweet" of the finches, and began to imitate the canaries' song. His song is now an almost perfect copy of the canaries' notes, and his own particular note is quite lost. Moreover, Mr. Paul adds that a pair of little green parraquets are also learning the canaries' song. "Within a very few days of their arrival they began to try 'notes,' and already the imitation is laughably correct, the 'squawky,' parrot-like voice making the song only the more ludicrous."

THE first scientific meeting of the Challenger Society for the Promotion of the Study of Oceanic Zoology and Botany was held on April 29, Dr. R. N. Wolfenden in the chair. In a paper on bipolarity, Dr. G. H. Fowler cited recent memoirs to show that, in spite of a good deal of destructive criticism, a *prima facie* case had been made out for a marked similarity (amounting in some instances to specific identity) between the two sub-Polar faunas. Dr. Wolfenden gave a preliminary account of the Copepoda collected by Mr. J. S. Gardiner in the Maldive Archipelago. More than ninety species had been already identified, of which some sixteen were new. Mr. E. W. L. Holt exhibited and made remarks on a new Gnathophausia from deep water. A committee was appointed to inquire whether it will be possible for the Society to undertake a card catalogue for oceanic work.

THE monthly *Bulletin* published by the Philippine Weather Bureau under the direction of the Rev. J. Algué, S.J., contains much valuable information relating to the meteorology and microseismic movements of the Archipelago; the tables include meteorological data deduced from hourly observations made at the Manila Observatory, and rainfall and temperature data at a considerable number of stations. The last *Bulletin* we have received, for November, 1902, gives an account and the track of a typhoon which occurred between November 7 and 12. This typhoon was one of the most rapid that has been experienced, and its speed did not decrease until it reached the Asiatic continent. The map shows that at noon on November 7 it was near the meridian of 135° east, and that twenty-four hours later it had already reached 122° east longitude, and that it entered Luzon during the afternoon of that day. It speaks well for the efficiency of the forecasting department of the observatory that it was able to give timely warning of the approach of the storm to the provinces threatened.

THE Meteorological Office pilot chart for May shows that there are immense quantities of icebergs and field-ice about the Newfoundland banks, so much, indeed, that the steamship owners have been compelled to order their commanders to disregard the international steamer routes, and keep about sixty miles to the southward, so as to endeavour to keep clear of the danger. A number of bergs have been sighted southward of the 41st parallel, beyond the southern point of the Great Bank, and they extend thence northward in vast numbers up the edge of the bank to about the 50th parallel, and no doubt far beyond, while they are scattered as far eastward as the 40th meridian and westward to the 55th meridian. In addition quantities of field-ice, drifting out of the St. Lawrence by Cabot Strait, render navigation in the neighbourhood of Cape Breton and the south of Newfoundland dangerous. It is many years since there was so much ice in the neighbourhood.

NEGOTIATIONS are in progress with the Danish Government for establishing wireless communication to Iceland by the Marconi system. A provisional agreement has been made between the Marconi Co. and a Danish association by which the latter has the option of carrying out the project; it has not yet been decided whether the communication shall be direct between Iceland, the Faröe Islands and Jutland, or between the islands and Scotland.

THE full text of the Government Bill "to facilitate the introduction and use of electrical power on railways," which was read for a first time last month, has now been printed. The chief effect of the Bill is to give the Board of Trade power to make orders authorising railway companies to use electricity as motive power, and to generate such power or make agreements for its supply. There are several other clauses in the Bill relating to provisions which would be necessary in the case of a railway company changing over partly or wholly to electrical working. The Bill, as it facilitates acquiring the necessary powers for electrical working by doing away with the necessity for introducing a private Bill, can only help forward progress in this direction. The Government is certainly to be congratulated on having, for once in a way, recognised the probable developments of science before it is too late, and we hope that the Bill will soon become law, and that the railway companies will avail themselves of its provisions.

SOME interesting evidence was given before the departmental committee on electricity in mines by Mr. Selby Bigge, especially in relation to the position of this country in comparison with America and continental countries. Mr. Bigge stated that he thought this country was very much behindhand, not only in the application of electricity to mining, but in the manufacture of electrical machinery generally. This he attributed partly to the restrictive nature of our legislation, and partly to the lack of scientific training on the part of the managers and others in authority. He instanced numbers of examples of electrical mining in-

stallations on the Continent, laying special stress on the application of three-phase working and the use of high voltages which this system permitted; he even went so far as to say that, paradoxical as he might seem, the higher voltages were probably safer, as the workmen, knowing that any tampering with the mains meant certain death, left them severely alone. For the actual machinery, 500 to 700 volts was a suitable pressure, but 1000 to 3000 volts might be used with advantage for transmission for considerable distances into the mines. Other evidence of an interesting nature was given before the committee, which is still sitting.

OFFICIAL statistics have on several occasions been collected as to the number of horses and other beasts of burden in Italy, but statistics regarding educational matters appear to be few and far between. The only records of the total attendances in Italian schools or colleges under the control of public or religious bodies refer to the year 1870. For private boys' schools results were collected from 1879, and for girls' schools from 1887, but in no case does information extend beyond 1894. Prof. Amato Amati, writing in the Lombardy *Rendiconti*, now asks for an official census of the private schools and educational institutions of Italy.

VARIOUS experimenters have obtained interference between light-waves with a difference of path reaching in one case as much as 790,000 wave-lengths. Profs. Lummer and Gehrcke now describe experiments in the *Verhandlungen* of the German Physical Society, in which interference phenomena were obtained after nine reflections at the surfaces of a uniform plate, representing a difference of path of 2,600,000 wave-lengths, and they draw the conclusion that among the particles of vapour in the mercury arc used as the source of light, the greater portion send out light capable of producing interference for a longer time than the interval (less than 10^{-8} of a second) in which $2\frac{1}{2}$ million waves are emitted.

THE importance of a convenient, accurate, and at the same time readily understood designation of musical notes in connection with the study of audition and partial deafness forms the subject of a paper by Sir W. R. Gowers, F.R.S., in the *Review of Neurology and Psychiatry* for April. At present there is no uniformity of notation, and the notation adopted by Helmholtz was merely an old and inconvenient notation used in organ construction. The present writer proposes to use C to denote the "middle C" (frequency 264), to use C^1, C^2, C^3 to denote the successive octaves *above*, and to use C_1, C_2, C_3 to denote the successive octaves *below* middle C, each octave extending to the B above.

IN describing the brain of the walrus, Mr. P. A. Fish (*Proc.* U.S. Nat. Mus., No. 1325) shows that the general plan of the fissures corresponds to that obtaining in Carnivora generally, and more especially seals.

THE Natural History Branch of the British Museum has received from Lord Crawford a small but interesting series of birds' skins collected by Mr. M. J. Nichöll on St. Paul and Noronha Islands, off the Brazilian coast. The only specimens from the latter island previously in the collection were obtained by Dr. H. N. Ridley in 1886.

IN vol. iii., part iii., of the *Annals* of the S. African Museum, Mr. G. A. Boulenger describes six new forms of perch-like fishes from the Natal coast. Recent issues of the *Proc.* U.S. Nat. Mus. contain papers on the band-fishes (Cepolidæ) and loaches (Cobitidæ) of Japan, by Messrs. Jordan and Fowler.

IN the course of a series of notes on the ornithology of Norfolk for 1902, published in the April number of the *Zoologist*, Mr. J. H. Gurney directs attention to the great migration of rooks and other members of the crow family which took place on the east coast during October of last year. The greater number of the immigrants were rooks, and the movement extended at least as far as Lincolnshire. Several rare birds are recorded as stragglers. Mr. Gurney adds that there is no good news to record of the great bustards which were turned down at Brandon in 1900. Of the original fifteen, only a single pair now remain; the hen laid a couple of eggs, which were incubated for six weeks without a successful result.

WE have received from Prof. W. C. M'Intosh a copy of a pamphlet on British fisheries' investigations and the international scheme. After referring to past and present investigations in connection with British fisheries, the author discusses the international scheme for the systematic biological survey of the North Sea, to which allusion has recently been made in our columns, urging that if the British Government resolves to participate in the scheme, attention should be concentrated on the habits and development of fishes and their food-supplies to the exclusion of subjects connected with hydrography. In regard to the supposed deterioration of our fisheries, Prof. M'Intosh is an optimist, remarking that "There is no fear of the extinction of any species, especially of those important to man. Furthermore, fishes have abounded in the primæval as in the modern seas, although the ravages of the gigantic reptilian and other fish-destroyers—which in some instances were distributed over the whole expanse of the ocean—could not have been less than even the far-reaching efforts of man. In neither period has extinction ensued from the prevailing agencies, nor is it likely to take place under these conditions in the future."

AN account of the structure and properties of a leguminous liane, *Derris uliginosa*, the leaves of which have been used as a fish poison by Fijian islanders, has been received from the Wellcome Research Laboratories. A description of the anatomy of the stem is furnished by Mr. Perrédès, from which it appears that irregular secondary vascular structures arise in the cortex. As a result of chemical investigation, Dr. Power discovered a considerable amount of tannin and various resinous substances. The toxic action is attributed to a constituent of that part of the resin which is soluble in chloroform, and not to the tannin.

THE progress of the German East African colony may be studied in the reports presented by the officers in charge of districts, which are embodied in the *Berichte* issued from Dar-es-Salâm. The native food resources are matama, maize, manioc, and in some parts bananas. Owing to the risks of failure of the three first, the natives have been encouraged to take up the cultivation of rice and sweet potatoes. As a source of revenue extensive plantations of coffee have been started by German companies, and on a smaller scale the cultivation of coco-palms, agave and ceara rubber is being extended with promising results.

OF the papers read before the American Society for Plant Morphology and Physiology, two contributed by Dr. E. F. Smith refer to bacterial diseases attacking Japanese plum trees and sweet corn, in both of which cases the author concludes that infection takes place through the stomata. A paper by Prof. Duggar traces the inconsistency of the osmotic action of certain salts on marine algæ to their toxic action, and potassium salts were found to be more

poisonous than the salts of calcium or magnesium. Prof. Jeffrey outlines an anatomical clue to the phylogeny of the monocotyledons which would derive them from dicotyledons. A suggestive paper by Prof. Toumey discusses the initial root system of tree seedlings.

THE latest addition to the useful series of short scientific memoirs published in Paris by M. C. Naud under the name *Scientia* is by Dr. L. Décombe, and is entitled "La Compressibilité des Gaz Réels." This is the twenty-first volume in the series dealing with physical and mathematical subjects.

THE Cambridge University Press has published the second part of vol. ii. of the "Reports of the Cambridge Anthropological Expedition to Torres Straits," which deals with physiology and psychology. The fasciculus contains sections by Mr. Charles S. Myers on hearing, smell, taste and reaction-times, and by Mr. W. McDougall on cutaneous sensations, muscular sense, and variations of blood-pressure.

THE decision of the Government to continue the present temporary Vaccination Act for one year has met with the approval of conscientious objectors, whose case Mr. Alexander Paul appears to take up in his little book, "The Vaccination Problem in 1903, and the Impracticability of Compulsion," recently published by Messrs. P. S. King and Son. The book should be useful in making clear the position of the objectors, so that the difficulties they put forward can be satisfactorily met when occasion requires it.

THE Orient-Pacific Line have published their pleasure cruise arrangements for the forthcoming Norway season. Three steamers will be employed, viz. the *Orient*, the *Cuzco* and the *Ophir*. The cruises begin on June 11, and vary in length from twenty to twenty-eight days. In addition to the attractions of Norwegian scenery and the Midnight Sun, the programme includes a visit to the glaciers of Spitsbergen with a prospect of seeing the Polar pack.

MR. A. R. HINKS writes in the *Monthly Review* for May on the evidence for life on Mars, and his article is illustrated by two maps of the canals or channels observed by Schiaparelli. The article is largely taken up with an account of Mr. Percival Lowell's observations of Mars at Flagstaff, in Arizona, and the conclusions drawn by Mr. Lowell, following a suggestion of Schiaparelli, as to the existence on Mars of a great irrigation system.

THE report of the council of the Hampstead Scientific Society for the year 1902 shows that the association continues its commendable activity. Among the lectures organised by the Society during the year may be mentioned those of Prof. Boyd Dawkins, F.R.S., on the forest primeval of the Coal-measures; Mrs. Dr. Bryant, on bees as builders of the honeycomb and otherwise; and Dr. Shenton, on medical applications of Röntgen rays. But much of the useful work of the Society is accomplished in sectional meetings, which are held in connection with the astronomical, the natural history, and the photographic sections two or three times a month. The example set by the Hampstead Society might with advantage be more widely copied.

CONSIDERABLE evidence is being accumulated at the present time which is apparently strongly antagonistic to the view that electrically charged ions are the factors which are directly active in all cases of chemical change. In the March number of the *Journal of Physical Chemistry*, Mr. H. E. Patten gives an account of experiments on the interaction of metals and hydrochloric acid in various perfectly anhydrous solvents. The solvents employed were benzene, chloroform, tin and silicon tetrachlorides, phosphorus and arsenic trichlorides, antimony pentachloride, sulphur monochloride, and thionylchloride. These solvents had a smaller conductivity than air, and yet zinc was in all cases directly acted upon by the acid.

AN interesting study of the modifications of acetaldehyde is the subject of a paper by R. Hollmann in the *Zeitschrift für physikalische Chemie*. Experimental data are given which show clearly the relationships existing between acetaldehyde and paraldehyde for temperatures ranging from −100° C. to 300° C. Of special interest are the observations relating to the composition of the liquid substance in its natural state of equilibrium. At the melting point (6·75° C.) the liquid consists of 88·3 per cent. of molecules of paraldehyde, whilst at the boiling point (41·6° C.) the molecular proportion is 53·4, and at the critical temperature (217° C.) only 11 per cent.

THE additions to the Zoological Society's Gardens during the past week include a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. H. R. Harger; a Springbok (*Gazella euchore*) from South Africa, two Feline Dourocoulis (*Nyctipithecus vociferans*) from Southern Brazil, two Violet-necked Cassowaries (*Casuarius violicollis*) from the Aru Islands, four White-eared Bulbuls (*Pycnonotus leucotis*), an Indian Python (*Python molurus*), four Saccobranchs (*Saccobranchus fossilis*) from India, three Grey-breasted Bullfinches (*Pyrrhula griseiventris*) from Japan, three Mocassin Snakes (*Tropidonotus fasciatus*) from North America, five Red-spotted Lizards (*Eremias rubropunctata*) from Egypt, a Delalande's Gecko (*Tarentola delalandii*) from West Africa, deposited; a Diamond Snake (*Python spilotes*), three Brush Turkeys (*Talegalla lathami*) from Australia, purchased; on Axis Deer (*Cervus axis*), eight American Timber Wolves (*Canis occidentalis*), two Crab-eating Raccoons (*Procyon cancrivorus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A telegram received from the Kiel Centralstelle informs us that Mr. Grigg, observing at Mr. Tebbutt's observatory, Windsor, New South Wales, discovered a new comet on April 17. The position of this object at 6h. 44m. 2s. (M.T. Windsor) on April 27 was:—

R.A. = 4h. 3m. 24s.
Dec. = 16° 23′ 25″ south.

The daily movement in R.A. is +1° 26′, and in declination +0° 27′; the announcement says nothing about the comet's brightness.

The above position is a little s.f. of γ Eridani.

NOVA GEMINORUM.—A telegram received from Prof. E. C. Pickering on April 22, published in No. 3864 of the *Astronomische Nachrichten*, states that "the light of Nova Geminorum is increasing."

THE PARTIAL ECLIPSE OF THE MOON ON APRIL 11.—The most striking feature of this eclipse was the blackness of the eclipsed surface, for it was not possible to see any of the details on that portion of the surface which was covered by the shadow. In a paper published in No. 16 (1903) of the *Comptes rendus*, M. Montangerand describes the results of the attempts he made to photograph that portion of the lunar surface eclipsed by the earth's shadow.

Using the astrographic-chart telescope and Lumière plates, and giving an exposure of one second to each plate, he obtained eleven negatives, two of which, Nos. vii. (Lumière "blue") and ix. (Lumière panchromatic), show the contour of the eclipsed moon, but no surface details.

The visual observations corroborate the photographs in showing that at this eclipse the shadow was especially black, so that no details of the eclipsed surface could either be seen or photographed. This result differs greatly from that recorded for the eclipses of December, 1898, and December, 1899, when the eclipsed surface was plainly visible and of a marked ruddy colour.

THE OCCURRENCE OF SPARK LINES IN ARC SPECTRA.—In a paper which recently appeared in the *Sitzungsberichte der K. Akademie zu Berlin* (January 22), Messrs. J. Hartmann and G. Eberhard give the results of a number of experiments they have made in order to determine under what conditions various lines, usually associated with spark spectra, may appear in the spectrum of the arc.

In the cases of magnesium and silicon—which are so important when considering stellar spectra—the authors found that when the arc was produced under water, using metallic poles, the magnesium line at λ 4481 and the silicon lines at λλ 4128 and 4131 were produced, although all three are usually called "spark" lines. In the case of zinc, the "spark" lines at λλ 4912 and 4925 were obtained under similar conditions.

The authors have also photographed the spectra of these metals when the arc was enclosed in an atmosphere of hydrogen, and again, under these conditions, the "spark" lines appeared. From this similarity of the results Messrs. Hartmann and Eberhard arrive at the conclusion that, when the arc is struck under water, it immediately becomes surrounded by an atmosphere of hydrogen, produced by the decomposition of the water, and so the same results under the two different primary conditions are obtained (*Astronomische Nachrichten*, No. 3858).

FOUR STARS WITH VARIABLE RADIAL VELOCITIES.—In *Bulletin* No. 31 of the Lick Observatory, Mr. H. M. Reese announces the discovery of four more stars having variable velocities in the line of sight; they are as follows:—

υ Andromedae.—Plates secured on October 8 and November 5, 1902, and January 14, 1903, show velocities of −17 km., −76 km., and +49 km. respectively. The spectrum shows few lines, and the hydrogen lines are broad, but the helium lines are fine and easily measurable.

π^4 *Orionis.*—The plates obtained on October 6, 1902, January 4 and January 12, 1903, indicate velocities of +43 km., ±0 km., and +6 km. respectively, the spectrum being similar to *υ* Andromedæ.

σ Geminorum.—Velocities of +74 km., +12 km., +9 km. and +69 km. are indicated by negatives obtained on March 16, 1902, January 12, 13, and February 15, 1903, respectively. The lines, though numerous, are rather hazy, but they give trustworthy results.

ι Argus.—The variable velocity of this star was discovered by Prof. Campbell from the comparison of a plate obtained on February 21, 1898, with previous measures. A series of seven photographs obtained between February 23, 1897, and February 18, 1902, shows a range of velocity from +41·9 km. to +50·3 km.

The photographs mentioned above have been obtained with the Mills spectrograph, and measured by Messrs. Reese and Curtis. Mr. Reese also announces that the star ϕ^2 Orionis is an especially interesting object on account of its great radial velocity, plates obtained on October 28, November 24, and December 30, 1902, indicating velocities of +94 km., +102 km., and +96 km. respectively. The range of 8 km. may not be taken as indicating a variable velocity for this star, for although the photographs show fairly good lines, the second one—in which the variation appears—was very much under-exposed.

THE HARVARD MERIDIAN PHOTOMETER OBSERVATIONS.—Part ii. vol. xliv. of the Harvard College Observatory *Annals* is devoted to a description of the reduction of the observations made with the meridian photometer during the years 1892–98. The editor, Prof. E. C. Pickering, gives a detailed description of the meridian photometer and the methods pursued in making the observations. This description is followed by tables giving the results of the observations of Harvard photometer and A.G. catalogue stars made during the period named above, each table being followed by voluminous notes as to the peculiarities of the observed objects and the observing conditions.

ENGINEERING EDUCATION ABROAD.

THE conditions governing the competition among the great manufacturing countries for the markets of the world have, during the last thirty years, undergone profound modification. At the beginning of the latter half of last century British manufacturers held an unique position which secured for them what was practically the monopoly in some departments of the world's trade. The reasons for this fortunate position are too well known to require elaborate recapitulation. It is enough to remember that while other countries were on one hand engaged in war and on the other in maturing a stable and enduring constitution, Britain was establishing flourishing manufacturing centres, which, with the assistance of her possession of coal and iron, supplemented as it was by the natural endowments of her citizens so far as perseverance and inventiveness were concerned, resulted in her becoming the world's workshop. In no direction was this supremacy more pronounced than in the several branches of the engineering trades. But since then great changes have taken place. By carefully laid plans and persistent effort, other countries have succeeded in overcoming their disadvantages, and as a result of the provisions they have made for the education of their young men in scientific technology, the British manufacturer has now to reckon with formidable German and American competitors.

The changed conditions have been made the subject of study by several authorities in this country, one of the most recent being Prof. W. E. Dalby, who has studied the question of the education provided for engineers in America, Germany and Switzerland. The opportunity which his commission from Mr. Yarrow to report on the training of engineers in other countries has given Prof. Dalby make the recent papers read by him before the Institution of Naval Engineers and the Institution of Mechanical Engineers of exceptional value, and it is much to be hoped that the following facts from his papers, and the lessons to be drawn from them, may have a good effect in convincing our manufacturers and educational authorities that the higher education of those engaged in industrial pursuits has a direct and immediate effect on success in the struggle for commercial supremacy.

The paper read before the Institution of Naval Architects was concerned only with the education of engineers in the United States; that before the Institution of Mechanical Engineers included a study of the question in Germany and Switzerland also. It will be most convenient to take these countries in order. Beginning with the United States, the nature of the technical education in the best colleges may first be considered, and then the relation between the employers and the technically trained men graduating from these colleges.

America.—A good idea of the aims of the technical colleges of America may be gathered from the words of one of the chief founders of the Massachusetts Institute of Technology of Boston, who laid it down that the most truly practical education, even in an industrial point of view, is one founded in the thorough knowledge of scientific principles, which unites with habits of close observation and exact reasoning a large general cultivation. The highest grade of scientific culture is not too high a preparation for the labours of the mechanic and manufacturer, and there are in the history of social progress ample proofs that the abstract studies and researches of the philosopher are often the most beneficent sources of practical discovery and improvement.

Inspired by such enlightened views of technical education, it is not surprising that there has been a steady increase in the number of engineering students in the chief American colleges. The first table on p. 18 gives an idea of the growth of their engineering departments.

At Cornell University students of mechanical engineering and the allied branches do their work at Sibley College; there is a separate building for civil engineering and architecture. Sibley College is divided into eight departments, viz. mechanical engineering, mechanical laboratory instruction, electrical engineering, mechanic arts (workshops), industrial drawing and art, machine design, graduate schools of marine engineering, and the graduate school of railway mechanical engineering.

Showing Numbers of Students in Engineering in Certain Colleges.

	YALE. Civil, Mechnical, Electrical, Mining and Sanitary Eng. Students in the Sheffield Scientific School.	CORNELL. Civil, Mechanical and Electrical Students.	MASS. INST. Civil, Mechanical, Electrical and Mining Students.
1895-96	209	617	357
1896-97	174	623	352
1897-98	153	645	356
1898-99	166	686	347
1899-00	162	774	356
1900-01	163	844	372

The staff consists of thirty-six teachers and instructors, and this number includes six professors and four assistant professors, and eight non-resident lecturers. The staff is inadequate at the present to deal with the numbers of students in the college.

A great feature of this institution is its workshops. Here instruction is given in pattern-making, moulding, forging, fitting and turning, and the work done in them is real. All students in the college pass through the same course during the first three years. They may specialise in the fourth year in steam, marine, railway or electrical engineering with specialists in those subjects.

Admission to the course in the American college is by examination. To enter Cornell a student must be sixteen years of age, and to enter the Massachusetts Institute seventeen. The standard of examination is such that a youth from a good high school can pass. There is no freedom left to the student regarding his course of studies when once he has chosen his department. Examinations are frequent, and promotion from one year to another depends upon the result of them. The courses are really a carefully-thought-out and elaborately organised species of educational drill. As a general rule a man must go through with it or fall out.

At the Massachusetts Institute the courses are so arranged that a student can do his work in forty-eight hours per week. Half of this time is given to lectures, &c., at the college, the other half is assumed to be spent in private study. The same method appears to be in operation at Cornell, Harvard and Yale. An analysis of the courses shows what is understood by a technical education in the States; it is really four years of continuous hard work at a college equipped with engineering laboratories and workshops, and with all the educational apparatus for giving a scientific education.

It is interesting to note the attitude of employers in the United States to the men who study in the way just described in these American colleges. A point in which American practice is remarkably different from ours is that age is no limit to a man who wants to get practical work in the shops, providing he is a college graduate. Employers might not take on an apprentice after twenty-one years of age if he were not a graduate. College graduates in America never find that, whilst learning the scientific principles of their profession, they have grown too old to enter the workshops to learn the practical part. The general opinion seems to be that the educated man picks up his practice much quicker and more intelligently than the younger man with only an ordinary education. Generally speaking, the attitude of the American employer towards these graduates is one of distinct encouragement, and of advantage to both. The employer gets the advantage of a trained intellect, the employee gets the advantage of his employer's shops and business experience. The American employer keeps an "open door" for the technically trained man, whilst with us in England the door is too often closed by rules regarding age and the like, and the would-be apprentice not having sufficient means to pay a premium in addition to the amount he has already paid for his education. In cases where college graduates are taken on in England, they are, as a rule, expected to go through the same course in the shops as a boy entering straight from school. The Americans are more yielding in this respect, and do not insist upon the drudgery of the first few years.

Germany.—The Berlin Technical High School at Charlottenburg is a State institution, and its object is to give a specialised training in industrial subjects founded on a preliminary scientific education. The course, lasting four years, begins with scientific subjects, and gradually becomes more technical until in the fourth year all the subjects are specialised. German subjects are admitted to the school on the production of a "maturity certificate" from a German gymnasium or a Prussian real-gymnasium. The education given at the two kinds of schools corresponds very roughly with that given in the classical and modern courses of our public schools. The maturity certificate is obtained at the end of a nine years' course. Those admitted by means of this certificate are styled *Students*.

Persons who cannot obtain or have not obtained this certificate can be admitted on school certificates of a lower value, but for the departments of architecture, civil and mechanical engineering and naval architecture must in addition show that they have worked for at least one year in some works. Those entering in this way are styled *Hospitanten*. The school has recently been given the status of a university.

As an instructive indication of the importance attached to higher technical education in Germany, the tables which have been drawn up by Prof. Dalby showing the numbers of students and teachers at the Charlottenburg institution may be given :—

Students of Various Grades in Attendance for the Winter Half-Year, 1902-3.

	Studenten.	Hospitanten.	Total.
1. Architecture	477	262	739
2. Civil Engineering	647	42	689
3. Mechanical Engineering:			
Specialising in Mechanical Engineering	1319	180	1499
Specialising in Electrical Engineering	270	51	321
4. Naval Architecture:			
Specialising in Naval Architecture	241	18	259
Specialising in Marine Engineering	106	17	123
5. Chemistry and Metallurgy:			
Specialising in Chemistry	161	20	181
,, ,, Metallurgy	169	11	180
6. General Science	6	—	6
Persons admitted under special regulations from affiliated Institutions	—	—	80
Officers and Engineers from the Navy	—	—	301
Total	3396	601	4378

Teaching Staff.

	Architecture.	Civil Engineering.	Mechanical Engineering.	Naval Architecture.	Chemistry.	Science.
Professors	18	14	20	6	13	18
Priv. Docenten	17	8	8	1	17	15
Construction Engineers	—	—	7	2	—	—
Lecturers	—	—	—	—	—	2
Assistants	1	1	13	3	15	4
Honorary Assistants	53	33	67	9	10	27
Total	89	56	115	21	55	66

Expressed briefly, there are 4378 students of all kinds and 402 members of the teaching staff.

A distinguishing characteristic of the Berlin Technical High School is the right maintained by the students to choose their own courses of study. This freedom is common to German universities, and it follows that the educational authorities can only suggest courses of study, leaving the students free to follow their suggestions completely, or partially, or not at all. Nevertheless, very complete and elaborate courses have been arranged, and as a rule are followed by the students.

There is no attempt to teach workshop practice. Laboratory teaching is confined to the engine laboratory and the electrical laboratory, with a little practice in testing materials at the neighbouring Government testing establishment (Königliche mechanische-technische Versuchanstalt).

The most striking feature of the course is the relatively large amount of time devoted to machine construction, including machine drawing, graphic statics, descriptive geometry, and the lectures connected with the various forms of machines, in which exercises in the drawing office are given. Prof. Riedler, who is at the head of this department, carries on a large engineering practice in the building, employing between twenty and thirty draughtsmen. The majority of these men take part in teaching the subject, so that mechanical drawing and machine design are taught by practical draughtsmen engaged for the greater part of their time in actual designing. No better method than this could be devised, because to all intents and purposes the students are working under actual drawing-office conditions.

A student passing through this course has a large amount of drawing-office practice of an advanced character, but very little practical work. Whether this kind of training is the best is a matter of opinion, but Prof. Dalby thinks a course which makes less claim on the students' time for college work and allows more for practical work would, on the average, in the long run produce better engineers.

Switzerland.—The Polytechnic at Zurich is a State institution designed to give a specialised training in industrial subjects. The course lasts four years. Students are admitted by examination at eighteen years of age. A "maturity certificate" from a Swiss school is taken in lieu of an examination, or a student may be excused part of the entrance examination by presenting certain school certificates. During 1901–2, there were 181 Swiss students of civil engineering, 230 studying mechanical engineering, and 49 taking up architecture, and in addition 249 foreigners in the same departments.

The lectures and exercises as announced in the programme of the several departments are obligatory on the student. In each department, however, the students are allowed a choice in the third year. Once having chosen, they are obliged to follow the plan selected. As at Berlin, no attempt is made to teach workshop practice, but the bulk of the time is given to drawing-office work.

General Remarks.—In all the courses described, a common scientific basis in the first two years develops into widely divergent and specialised branches in the remainder of the course. It should be understood that both in the States and on the Continent many of the specialised lectures are given by men in the full practice of their profession, and who are not regular members of the teaching staff. The best courses in this country are arranged on practically the same basis, but the longest being three years, there is no time to develop the instruction into the specialised branches of engineering.

There is an essential difference in the method of training in America and Germany. In America the course of instruction is very exactly laid down, and the student is compelled to follow it step by step. Slight variations are permitted in the form of options, to use their term, in the later periods of the course. The student gets his degree from the gradually accumulating results of terminal and sessional examinations, ending finally with a thesis.

In Germany the students of their great technical high schools enjoy the freedom peculiar to the university system of that country. No student is compelled to take any special course. For his convenience definite courses are arranged and laid down in the school calendar, but the sequence of lectures therein stated is not binding. The courses are only recommendations, and students may follow them or not as they please. At Zurich the course is partly prescribed, partly selected.

The following table gives a good idea of the nature of the engineering courses in the three countries, the subjects studied, and the relative importance attached to each.

The Percentage Number of Hours' Instruction given in Various Mechanical Engineering Courses.

	Massachusetts Institute.	Cornell.	Berlin Technical High School.	Zurich Polytechnic.
Mathematics	8	5	14·5	19·2
Physics	5	8	6·8	6·0
Chemistry	7	7	1·7	3·0
Applied Mechanics	7	10[1]	22·5	19·5
Mechanism	4	—	8·0	—
Steam-Engine, including Thermodynamics	6	6	4·1	8·0
Mechanical Drawing[2]	26	20	31·0	39·3
Electrical Engineering	2	2	3·4	5·0
Commercial Subjects	2	—	8·0	—
Workshops	14	30	Nil	Nil
French	6	—	,,	,,
German	3	3	,,	,,
English	5	—	,,	,,
Engineering Laboratories	5	9	[3]	[3]
	100	100	100·0	100·0
Approximate Hours	3000	3000	4000	4000
Distributed over	Four Years.	Four Years.	Three Years.	Three Years.

The fourth year of the continental courses is not included, because it is so cut up with examination work. It must not be forgotten, however, that an American student actually receives 3000 hours' instruction; a German or Swiss student is only recommended to attend courses aggregating 4000 hours. Actually he may work just as many hours as he chooses. In brief, the American courses are more practical in character, they include more laboratory training than is recommended in the German course, and devote a large proportion of the course to the teaching of handicraft skill. In Charlottenburg and Zurich no attempt is made to teach handicraft skill, and the bulk of the training is given in the drawing-office, though in addition a considerable amount of time may be given to engine testing.

One thing is certain, the American, German, and Swiss student starts his course with a far better education on which to build than is the case with us. Much time is wasted at colleges here on teaching things which should have been taught at school. Prof. Dalby believes that the great defect of the British system of training engineers is the want of coordination between the colleges and the employers. If the employers will concern themselves with the question, he feels sure their attitude will speedily change.

The general opinion seemed to be that a course arranged so that the winter months are spent at college and the summer months in the works is a desirable one, and one from which good results may be expected. Such an arrangement obviously cannot be worked without the cooperation of the employers. This alternating system must not be regarded as experimental. Our Admiralty have had something very similar in operation for forty years, and the system has produced a famous roll of chief constructors. The Scottish universities lend themselves to the system, and Glasgow students in engineering consistently study in the winter and work in the summer.

[1] Includes Mechanism.

[2] Includes Freehand, Machine Drawing and the lectures connected with Machine Design.

[3] Laboratory courses are taken in addition, but it is difficult to estimate how much is recommended.

AMERICAN SYMBOLISM.

IN 1899 Mrs. Morris K. Jesup generously provided the means for a study of the Arapaho Indians, and Dr. Alfred L. Kroeber was entrusted with the work; his general description of the Arapaho and of their decorative art and symbolism recently published in the *Bulletin* of the American Museum of Natural History (vol. xviii. pp. 1–150, 1902) proves how well he acquitted himself of his task. Dr. Kroeber now has charge of the anthropological department of the University of California, and we may expect much good work from him in the future in this new field.

The Arapaho are typical Plains Indians, and belong to the linguistic stock of the western Algonkins. The fullest and most accurate account of these people has been given by Mr. James Mooney ("Ghost-Dance Religion," *Fourteenth Ann. Rept. Bureau Ethnol.*), and the sketch of their social organisation and life given by Dr. Kroeber is instructive, and to some extent supplements the previous descriptions.

The main value of Dr. Kroeber's memoir consists in the careful analysis of the meaning of a very large number of designs that ornament objects in every-day use, and in the wealth of the accompanying illustrations. The conscientious labour which this implies is deserving of the thanks of fellow-students of decorative art and symbolism.

There is a good deal of latitude in the interpretation of decorative designs employed by different individuals: usually an Indian refuses to interpret the ornamentation on an article belonging to someone else, giving as a reason that he does not know what that particular artist intended to represent. For example, the rhomboid or diamond-shaped symbol may signify the navel, a person, an eye, a lake, a star, life or abundance, a turtle, a buffalo-wallow, a hill or the interior of a tent. All except the first of these significations have also been found attached to very different symbols; thus, a person is also denoted by a small rectangle, a triangle or a square, by a cross, a dot or a line, as well as by rudely realistic designs. A lake may be represented by a square, a trapezoid, a triangle, a pentagon, a circle or other figures. The decorative symbolism is not intended as a means of communication, hence there is no fixed system of symbolism. One person thinks about the significance of his designs, while another considers chiefly their appearance. The former may have two or three interpretations for one symbol or design which are appropriate and coherent; the symbols of the latter will have their most conventional meaning, without much relation to a thought-out scheme. In either case, the Indian never dreams of making a picture that can be recognised by everyone at first sight. These peculiarities can be paralleled in other parts of North America, and, indeed, elsewhere.

A pictograph serves as a means of record or communication, and is normally not decorative; while this art is too decorative to allow of its being read in the same way; yet there is considerable similarity in the symbols used in both systems. Moreover, the significance of a piece of decoration is at times as extended and coherent as that of a pictograph.

Dr. Kroeber insists that the closeness of connection between this decorative symbolism and the religious life of the Indians cannot well be overestimated by a white man. All symbolism, even when decorative and unconnected with any ceremony, tends to be to the Indian a matter of a serious and religious nature. A. C. H.

THE ORIGIN OF NATURAL GAS AND PETROLEUM.

THE volcanic origin of natural gas and petroleum is strongly advocated by Mr. Eugene Coste in a paper read before the Canadian Mining Institute (March 5). The author points to the complete analogy of the products of the oil and gas fields with the products of volcanic solfataric action. These products are water, chloride salts, sulphur, sulphuretted hydrogen, carbonic acid and hydrocarbons. He brings forward facts upon which he bases his view that all the petroleum, natural gas, and bituminous fields or deposits are essentially the products of solfataric volcanic emanations, condensed and held in their passage upward in the porous tanks (sands, limestones, &c.) of all ages from the Archæan to the Quaternary. He instances the occurrence of carbon and hydrocarbons in gneisses and various ancient plutonic rocks. He likewise refers to the dolerite of the Lothians (described by Mr. H. M. Cadell), in which cavities of the rock are filled with a mineral wax not unlike the ozocerite of Galicia. The oil shales through which the igneous rocks have intruded were in Mr. Coste's opinion impregnated by solfataric emanations, for their bituminous character is local, and in proximity to the igneous rocks. Allusion is made to the occurrence of asphalts and oils along the faulted and broken margins of the Gulf of Mexico and Caribbean Sea, the great asphalt deposit of Trinidad filling the crater of an extinct volcano. Again, natural gas and petroleum are associated with mud volcanoes. The author therefore concludes that carbon and hydrocarbons are derived from deep-seated fluid magmas, in which they exist probably in the form of carbides. The "rock pressure" of natural gas is regarded as a remnant of the initial volcanic energy. This has been registered as high as 1525 lb. to the square inch, but is usually between 200 and 1000 lb., and is a constantly decreasing pressure from the time the gas is first used. The theory that artesian water is the cause of the gas pressure is regarded as untenable.

The author points out how generally the diversified "oil phenomena," which include gypsum, sulphur, dolomite, and salt, are met with in American and other oil and gas fields. Disturbed strata and planes of faulting gave access to volcanic emanations which brought up the various products; the rocks were variously impregnated according to the geological and physical conditions of the strata, and the products were sealed up when impervious unbroken strata remained above. In Galicia solid petroleum or ozocerite exists in veins cutting the strata in every direction, the most important being faults. Elsewhere oil occurs in the fractured strata, and such an elusive fluid, pent up under pressure, could not be in its original home. The local and seemingly accidental occurrence of the oil and gas, and even of bituminous shales, are considered by the author to favour his theory, for he observes that the sedimentary strata could not produce from a limited fossiliferous area the quantity of products. Thus, near Baku, in Russia, a small area of not more than eight square miles has now yielded more than 900 million barrels of oil. H. B. W.

SMITHSONIAN REPORT ON SCIENTIFIC WORK.

DR. S. P. LANGLEY, secretary of the Smithsonian Institution, has issued his report on the operations of the Institution during the year ending June 30, 1902, including the work in the United States National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park, and the Astrophysical Observatory.

Following the precedent of several years, there is given, in the body of the report, a general account of the affairs of the Institution and its bureaus, while an appendix presents more detailed statements by the persons in direct charge of the different branches of the work. Independently of this, the operations of the National Museum are fully treated in a separate volume of the Smithsonian Report, and the Report of the Bureau of American Ethnology constitutes a volume prepared under the supervision of the director of that Bureau.

The following extracts from the report will show that a vast amount of scientific work is being instituted and carried on under the auspices of the Institution.

Hodgkins Fund.—In connection with the administration of the Hodgkins fund, papers recording the advance of specialists along various interesting lines of investigation have been submitted, some of which are now in course of publication.

The report of the research on the spectrum conducted by Dr. Victor Schumann, of Leipzig, has received extensive additions during the year, notably through a detailed description of the ingenious apparatus used in his work. A second grant on behalf of Dr. Schumann has been approved during the year, and it is interesting to know that

Harvard University, recognising the value of his work, has also awarded him a grant. The new Physical Institute of the Royal Academy of Sciences in Leipzig has likewise aided this research by placing laboratory room at the disposal of Dr. Schumann, who, it is hoped, will be able in the near future to secure still more complete results from his painstaking experiments in vacuum spectroscopy.

The memoir by Dr. Carl Barus, issued as part of vol. xxix., Smithsonian Contributions to Knowledge, describes experiments with ionised air, begun by Dr. Barus some years since, and recently prosecuted under a Hodgkins grant from the Institution. The research was tributary to an investigation of the colours of cloudy condensation. Lord Rayleigh's famous theory, if applied, would stop at the deep reds of the first order, terminating in opaque, whereas in the laboratory experiments exceptionally brilliant colours, extending almost into the third order of Newton's series, may be produced. It was thus essential as a preliminary step to investigate appropriate means for the production of nuclei, to determine their number per cubic centimetre, their velocity, their association with ionisation, the effect of the pressure of an electric field, &c. This was the general trend of the experiments by Dr. Barus. The endeavour was made with the aid of the condensation tube to show that the nucleus has a specific velocity of its own, and that this is retained even in the absence of an electric field. The application of this principle to plate, to tubular, and to spherical condensers leads, in every case and in spite of the variation of method, to an order of values as to the number of particles in action, agreeing with the data obtained by other investigators from different experiments and theoretically different points of view. A second grant has been approved on behalf of Dr. Barus, and a new memoir on the structure of the nucleus, detailing experiments subsequent to those described in the volume just published, is soon to be submitted by him.

The experiments in air resistance by Mr. C. Canovetti, which were begun at Brescia, Italy, have been continued, and by means of an ingenious apparatus he has prosecuted a research which has been reported upon in detail, with illustrations accompanied by tables giving the numerical results attained.

Dr. von Lendenfeld, of the University of Prague, who has been assisted by a grant from the Hodgkins fund, reports that his studies are now sufficiently advanced to enable him to begin the preparation of his manuscript for publication. Telephotography has been extensively and successfully used in this research, and the summary of work already submitted is accompanied by interesting illustrations. A monograph embodying the results of the completed research, which will be published later, will present an anatomical and physiological study of insects, the lower vertebrates (Exocœtus, Draco, &c.), birds, mammals (Petaurus, Geleopithecus, &c.), and will treat of the polygenetic development of the organs of flight in animals. The physical properties of the air, wind velocities, resistance, &c., will be considered, and it is hoped that the publication will not only prove of general interest, but will become a valuable work of reference for students.

The research into the nature of vowels by Prof. Louis Bevier, of Rutgers College, has been reported on through a series of published articles, transmitted by the author to the Institution, which record in detail the results thus far obtained. The investigation is still in progress, the vowel series from "a" to "u" being now under analysis and discussion.

A grant has been approved on behalf of Mr. E. C. Huffaker for the construction and practical application of a device intended to produce a uniform and measured flow of air through a tube of any desired diameter. This apparatus is primarily designed for use in connection with investigations in the line of biology, and it has already been applied to exact experiments in the development of the embryo in the egg. It is hoped that by means of this invention facts may be established which will prove of practical value.

The meteorological investigations in connection with air currents at varying altitudes, heretofore reported on as conducted by Mr. A. L. Rotch at Blue Hill Meteorological Observatory, have been supplemented this year by a series of experiments on the lift and drift of the wind on plane and curved surfaces.

Dr. Morris W. Travers, of University College, London, has received a grant, and is now engaged in an investigation which will deal largely with the liquid properties of hydrogen.

National Museum.—This museum, established in the fundamental Act creating the Smithsonian Institution, grew up largely from its private collections, but it is important to consider that now it has grown into something which represents more nearly the large purpose of Congress in its foundation and that it is becoming a "National" Museum. It differs from most other museums in that its primary function was held to be not so much the entertainment or instruction of the resident population as the preservation and arrangement of the collections brought together by the Government of the United States. These collections now outnumber by some millions of specimens those which it has been possible to place upon exhibition in the present inadequate quarters. The number of specimens received during the year was about 450,000, making the total number of objects nearly five and a half millions.

Bureau of American Ethnology.—The work of this Bureau has related largely to a study of the origin, physical and mental characteristics, arts and industries, food supply, social and political institutions, religions, and languages of native American tribes.

Field work was conducted in Alaska, Arizona, California, and in several other States and Territories, as also in British Columbia, Mexico, Greenland, and in Porto Rico, while useful information and material was obtained from correspondents and special collaborators. Special attention was devoted to a study of those aboriginal industries which appeared to bear practical relations to modern life, particularly to aboriginal methods of house building and irrigation, and to food sources in those tropical and arid regions that formerly sustained a population five to ten times larger than at the present day. A noteworthy investigation of aboriginal industries was conducted in Porto Rico, and a special report of the native resources of that island is in preparation.

A special study was made of a ceremony among the Pawnee Indians embracing songs of interest in the development of music and poetry, and to early phases of the drama, the memoir being accompanied by the primitive music recorded by the aid of the graphophone, and with photographs of movements and objects introduced in the ceremony.

International Exchanges.—During the last fiscal year there was handled 125,796 packages, the packages sent abroad numbering 87,149, and those received from foreign countries 38,647. The number of parcels exchanged with Germany was 20,679, and with Great Britain 19,912. France comes next with 11,378, and then Mexico, Italy, Austria-Hungary, and Russia.

It has long seemed desirable to establish more adequate exchange relations with Japan and China, but efforts in that direction have so far been without success. In Great Britain, Germany, and Austria-Hungary, it is still necessary to employ salaried agents to carry on the work, the Governments of these countries for various reasons not yet having organised international exchange bureaus.

Five years ago, in 1897, the total number of correspondents or participants in the exchange service was 28,008, while the aggregate has now reached 38,200 addresses of libraries and individuals in 154 countries scattered all over the civilised world, even in some of the remotest corners of India, Asia, Australia, and Polynesia.

The general benefit of the service to the scientific world can hardly be measured. Largely as a result of these international exchanges there has accumulated in the Library of U.S. Congress a mass of scientific and Government publications that is probably not surpassed anywhere, and could scarcely have been secured in any other way.

National Zoological Park.—Dr. Langley has in previous years called the attention of the Regents to the want of a grant for collecting and preserving some of the great land and marine specimens of the Western territory now rapidly approaching extinction, and he again urges the immediate need of doing something, even on the smallest scale, before it is entirely too late. It is hoped that means will be provided to meet these wants by the establishment of at least

two small stations or ranches in Alaska, one in the interior, where may be secured specimens of the great moose, the great bear, and other disappearing animals of the land fauna; the other "ranch" to be on the coast for the collection of the walrus, the sea otter, the great sea lion of Steller, and other important vanishing marine species.

The animals in the National Zoological Park at the close of the fiscal year included 506 mammals, 232 birds, and 145 reptiles. The accessions of the year numbered 314. More than half of these accessions were gifts to the Government, several of the most interesting animals having been secured through the cooperation of United States consuls and other officials. A fine specimen of grizzly bear, also some antelope, deer, elk, and cinnamon bears were received from the Yellowstone National Park.

The native game, formerly everywhere plentiful, has grown so nearly inaccessible that only after years of effort have there at last been procured a single young male specimen of the great Kodiak bear and two big horn or Rocky Mountain sheep.

The Astrophysical Observatory.—The principal work of the Astrophysical Observatory during the past year has continued to be the study of the sun and its radiation. While fully acknowledging the interesting nature of astrophysical investigation of the stars and nebulæ, the study of the sun has a far superior practical importance, for were the former bodies to be wholly blotted out, they would be missed chiefly as objects of scientific interest, while with the sun would be abolished life itself. The solar researches have mainly been concerned with determining the amount and nature of the absorption of solar radiation in the earth's atmosphere and in the solar envelope. These researches are preliminary to, and form an essential part of, the measurement of the total radiation of the sun. A presumption exists, almost amounting to certainty, that the total radiation of the sun is variable in some relation to the appearance of sun-spots, but nothing is yet known to fix definitely the amount of this supposed variability or to measure its effect upon the earth, though that effect, if so fixed, cannot but be of interest to every inhabitant of the earth's surface.

The instrumental means, which thus have been the subject of incessant study and improvement here during the past ten years, for investigating such questions, are more efficient than at any previous time. The detailed report shows that automatic bolometric curves accurately representative of the amount and distribution of the solar energy at the observer's station may now be obtained in a few minutes, covering nearly the whole spectral region which reaches sea level, and where occurs much of the great and varying absorption by water vapour which influences our terrestrial temperatures so greatly.

Some twenty years ago, when Dr. Langley invented his "bolometer," the instrument was able to measure temperature to about one one-hundred-thousandth of a degree. Since then, during fifteen years of constant advance, latterly associated with a great improvement of the adjuncts, particularly of the galvanometer, at the hands of Mr. C. G. Abbot, this has been brought to measure somewhat less than one-hundred-millionth of a degree, and this almost infinitesimal amount is distinguished with readiness and precision. It is this increased precision which is associated with all the improvements in the work of the year here described.

It is the variability of the absorption of our air which now offers the greatest difficulty to the work. Dr. Langley cherishes the hope that a solar observatory will one day be established high in a clear and dry air, the chief aim of which shall be to solve the questions of the amount of radiation of the sun, the changes in this total amount, and the consequences of such changes on the earth.

The interest of this solar study is peculiar among all the subjects of astronomical research, for it is not only a scientific but a utilitarian interest of such high importance that it has among its remote possibilities the forecasting of the coming seasons and harvests, and of conditions immediately practical, from those which affect the price of the labourer's dinner up to those which, to use the weighty words of Prof. Newcomb, may bring to light not merely interesting cosmical processes, but "cosmical processes pregnant with the destiny of our race."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The General Board of Studies report that in their opinion it is expedient to reestablish the chair of surgery, which has been suspended since Sir George Humphry's death. They propose a stipend of 600*l.* a year, with freedom to undertake private practice, and the right to be *ex officio* surgeon to the hospital and to hold a college fellowship.

A special syndicate has been appointed to consider arrangements for the future conduct of the engineering department, in view of the approaching departure of Prof. Ewing. A bust of the late Dr. John Hopkinson has been presented to the Hopkinson Laboratory, and will be unveiled during the present term.

THE second reading of the London Education Bill was carried in the House of Commons on April 29 by 300 votes to 163.

AT a meeting of the Court of Governors of University College, Liverpool, held on May 2, the chairman alluded to the endowment of a chair of electrotechnics, for which special purpose a donation of 10,000*l.* had been made by Mr. Jardine, and stated that they hoped to receive other special donations in order to establish professorships of applied mechanics and applied mathematics. A new building for electrotechnics and biology is to be erected, which it is hoped will be one of the most perfect of the kind in the country. It was also announced that, assuming all went well, and that the charter constituting the Liverpool University College a separate university was granted in June or early in July, the necessary Act of Parliament would probably be passed during the present session.

THE annual conference of the presidents, deans and executive officers of many of the institutions for the higher education of women in the United States was held this year at Smith College on April 18. The association, which numbers among its members eleven colleges for women and co-educational institutions, as well as associations and individuals, maintains a table at the Zoological Station at Naples, awarding places at it to from one to five persons each year. A place at the American Women's Table at this Station for 1903–4 was awarded to Dr. Grace Emily Cooley, associate professor of botany at Wellesley College, who will thus become scholar of the association. An additional award has, however, been made this year, that of the prize of 200*l.* offered two years ago for the best piece of scientific research work done by a woman. Twelve professors representing the biological, chemical, and physiological sciences act as board of examiners for the association. This year they considered eleven scientific investigations, and awarded the prize to Dr. Florence R. Sabin, assistant in anatomy at the Johns Hopkins University Medical School, for the results of an investigation on the origin of the lymphatic system. Honourable mention was given to the paper on the life-history of Pinus by Miss Margaret Ferguson. The prize of 200*l.* is again offered, to be awarded in 1905.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 24.—Mr. T. H. Blakesley, vice-president, in the chair.—Mr. W. B. **Croft** exhibited several novel and ingenious pieces of physical apparatus.—Dimensional analysis of physical quantities and the correlation of units, by Mr. A. F. **Ravenshear**. The object of this paper is to knit together various divergent views which are current on the subject of dimensions. It is shown that while (1) dimensional analysis and the correlation of units of different kinds can be pursued in one direction until, with completed correlation, we arrive at degrees of undifferentiated quantity, a different procedure may be followed which (2) gives rise to various systems of dimensions descriptive of the physical relationships of the quantities treated. The conditions giving rise to dimensional relations are first set out, and it is proposed to distinguish the purely quantita-

tive reading of a dimensional formula by enclosing the sign of equality in square brackets thus :—

$$[\text{force}][=][\text{M}][\text{L}][\text{T}^{-2}]$$

and the reading of it as a physical identity or equivalence thus :—

$$[\text{force}] \equiv [\text{M}][\text{L}][\text{T}^{-2}].$$

The dimensional relation $M = L^3T^{-2}$ derived from the law of gravitation is examined at length. This relation, combined with the demand for the complete correlation of all dynamical units, is shown to require the adoption of the convention

$$[\text{L}][=][\text{T}][=][\text{M}].$$

This result is interpreted by (1) above. Systems of dimensions are next discussed, with the aid of illustrative tables, and it is shown that by employing different physical laws as bases many different systems may be constructed.—Mr. R. J. **Sowter** read a note on dimensions of physical quantities. Mr. Ravenshear has shown that any physical quantity is expressible in terms of the dynamical quantities L, M and T, in different ways, but that all the various ways are connected with one another by an index law. One interpretation of this is that the dynamical factors are complete in themselves. They express change-ratios, and have no qualitative significance. μ, k, γ, &c. do not contain dynamical factors, but carry with them the physical qualities or characteristics of the quantities associated with them. Any physical quantity, on this hypothesis, is expressible as $= N(D^n)q$, where N is a mere number, (D^n) is a dynamical factor indicating a quantitative measurement process, and q is a quality factor of the nature of Q.

Geological Society, April 8.—Mr. J. J. H. Teall, F.R.S., vice-president, in the chair.—On the probable source of some of the pebbles of the Triassic Pebble-Beds of South Devon and of the midland counties, by Mr. O. A. **Shrubsole.** The author describes the Budleigh-Salterton Pebble-Beds. The supposition is natural that Devonian rocks were once represented either in the Calvados district or in some region in the same drainage-area as that which has supplied the Ordovician element. The Grès de May of Normandy appears capable of furnishing abundant material, not only for the Ordovician pebbles of the Budleigh-Salterton Pebble-Bed, but also for a great deal more. A list of species common to the Grès de May, of May itself, and the Budleigh-Salterton deposit is given. The author is struck with the resemblance of the Midland Bunter to that of Devon. Strong family likenesses subsist between certain specimens in the northern and southern Bunter and some of the undisturbed rocks of Normandy. A list of fossils from the Midland Bunter contains three southern forms. Fourteen out of twenty of the Drift and Bunter fossils are found at Budleigh-Salterton and in Normandy.—Note on the occurrence of Keisley-Limestone Pebbles in the Red Sandstone-Rocks of Peel (Isle of Man), by Mr. E. L. **Gill.** Pebbles of a coarsely-crystalline, greyish-white, mottled limestone, collected by Prof. W. Boyd Dawkins from the conglomerates at Whitestrand, contain the following fossils :—*Illaenus Bowmanni*, var. *brevicapitatus*, *Primitia Maccoyi*, *Orthis calligramma*, *O. testudinaria*, *O. biforata*, *Rafinesquina deltoidea*, *Plectambonites quinquecostata*, *Atrypa expansa*, *Hyatella Portlockiana*, *Dayia pentagonalis*, *Platyceras verisimile*, *Stenopora fibrosa*, and crinoid-stems. This assemblage of fossils corresponds strikingly with that of the Keisley Limestone, and it is therefore concluded that the pebbles have been derived from that rock.

DUBLIN.

Royal Irish Academy, April 27.—Prof. Atkinson, president, in the chair.—Observations on the temperature of the subterranean organs of plants, by Dr. Henry H. **Dixon.** Previous experimenters on the temperatures of plants have confined their investigations to the aërial organs. Dutrochet alone experimented with subterranean organs, but only after removal from the soil. He believed that these organs are at the same temperature as their surroundings. From the experiments described in this paper we may infer that (1) subterranean organs, *e.g.* bulbs, like aërial organs, may have during active growth a higher temperature than their surroundings. The amount of this temperature-elevation may be as much as 0·06° C. (2) After the period of active growth is passed, this temperature-elevation is no longer noticeable. (3) There is no true indication of a *spontaneous* periodic diurnal rise in the temperature of subterranean organs, such as has been recorded by other writers for aërial organs. A periodic diurnal rise may occur owing to the periodicity of the temperature of the surroundings, which in its turn may cause an increase in the metabolic activity of the plant, and so give rise to a periodic elevation of temperature. (4) In the less massive subterranean organs the temperature rise is not sufficient to make itself appreciable above the fluctuations of the surroundings and the errors of experiment. The paper also contains an account of the errors affecting the thermo-electric method of determining plant temperatures, and also of some suggestions with a view to minimising them.

PARIS.

Academy of Sciences, April 27.—M. Albert Gaudry in the chair.—The president announced the death of M. de Bussy, member of the section of geography and navigation.—On the radiation of polonium and on the secondary radiation which it produces, by M. Henri **Becquerel.** The radiation of polonium differs from that of radium by the absence of rays resembling the kathode rays. The chief portion of the polonium rays possesses identical properties with the α-rays of radium and the canal rays of Goldstein. Up to the present these have been the only polonium rays known, but the author has recently recognised the existence of other rays, distinguished by their powers of penetration. These penetrating rays produce effects which are in every way comparable with the penetrating rays of radium filtered through a considerable thickness of metal. Hence it would appear that of the three distinct kinds of radiation possessed by radium, polonium possesses only two, the part missing being that of a kathodic nature.—The eclipse of the moon of April 11 at the Observatory of Marseilles, by M. **Stephan.**—Observation of the partial eclipse of the moon of April 11 at the Observatory of Bordeaux, by M. G. **Rayet.** The atmospheric conditions were extremely favourable for observations; one peculiarity noticed in the eclipse was that whereas in ordinary eclipses the entire disc of the moon can be seen during the greater part of the eclipse, in this case the eclipsed part of the moon had completely disappeared. This was noticed both in the eye observations and the photographs.—The catalytic decomposition of alcohols by finely divided metals, allyl and benzyl alcohols, secondary and tertiary alcohols, by MM. Paul **Sabatier** and J. B. **Senderens.** It has been shown in previous papers that metallic copper, prepared by the reduction at a low temperature, reacts with the primary alcohols, giving the aldehyde and free hydrogen. This reaction has now been extended to allyl, benzyl, isopropyl and other secondary alcohols. Allyl alcohol gives a 50 per cent. yield of propyl aldehyde, and benzyl alcohol gives hydrogen and the aldehyde. Secondary alcohols give hydrogen and the corresponding ketone in good yields, provided that the temperature does not rise too high. Tertiary alcohols split up into water and ethylene hydrocarbons. Reduced nickel gives rise to similar reactions, but there is a tendency to further decomposition, and the yields are not so good.—M. Noether was elected a correspondant in the section of geometry in the place of the late M. Fuchs.—On the observation of the eclipse of the Moon of April 11, by M. P. **Puiseux.** The extreme blackness of the eclipsed portion of the moon, noticed by other observers, was also in evidence at Paris.—The eclipse of the moon of April 11–12, by M. A. **Kannapell.** The results of observations made at the Observatory of the Faculty of Sciences at Paris.—On the deadening of the tremors of the ground. The application of a bath with a thick layer of mercury, by M. Maurice **Hamy.** A study of the theory of the use of mercury baths in preventing oscillations. An apparatus designed to carry out the conditions indicated by these researches was installed in the neighbourhood of a 4 h.p. gas engine with very satisfactory results.—The calculation of the time and height of high tide by means of harmonic constants, by M. Rollet **de l'Isle.**—Observations of the sun made at the Observatory of Lyons with the 16 cm. Brunner equatorial during the first quarter of 1903, by M. J. **Guillaume.** The observations are given in three tables showing the number of spots, their distribution in latitude, and the distribution

of the faculæ in latitude.—On certain remarkable deformations, by M. Jules **Drach.**—On the carrying of the charge in experiments on electric convection, by M. N. **Vasilesco-Karpen.** A discussion of the question of a disc, carrying a variable electric charge, and rotating about its axis, as to how far the charge is carried round by its support? A calculation is given showing the number of turns made by the charge with respect to the disc in unit time. The slipping is proportional to the thickness of the disc and to the induced electromotive force.—On the cementation of iron, by M. Georges **Charpy.** Cementation is not limited by the solubility of carbon in iron. Under certain conditions, the iron may be completely converted into carbide of iron, or the carbon may be indefinitely converted into graphite by the action of a limited quantity of iron.—On the reduction of some compounds of the halogens with metals by hydrogen; the influence of pressure, by M. A. **Jouniaux.** The reduction of the chlorides, bromides, and iodides of silver and lead with hydrogen was studied at varying temperatures, and the experimental results compared with an expression deduced from thermodynamics.—On the electrolytic reduction of potassium chlorate, by M. D. **Tommasi.**—On a reaction giving rise to symmetrical diphenyl-pyrones, by M. R. **Fosse.** The method used consists in treating the phenol orthophosphates with potassium carbonate. Details are given for the reactions with the phosphates of phenyl, cresyl, and naphthyl.—The influence of the nature of the external medium on plant acidity, by MM. E. **Charabot** and A. **Hébert.** Those salts which favour the diminution of water in the plant are precisely those for which the ratio between the volatile acids esterified and the total volatile acidity is the highest.—The influence of the radium radiation on animals in the course of growth, by M. Georges **Bohn.**—On some proteolytic ferments associated with rennet in vegetables, by M. Maurice **Javillier.**—On the production of formic acid in alcoholic fermentation, by M. Pierre **Thomas.** Yeast cultivated in a mineral liquid containing sugar, a large surface of which is exposed to the air, may give rise to considerable quantities of formic acid if nitrogen in certain forms is present. Since ammonium salts and amides exist naturally in certain musts, it is not surprising to find formic acid in the resulting wines after fermentation.

DIARY OF SOCIETIES.

THURSDAY, MAY 7.

ROYAL SOCIETY, at 4.30.—On *Lagenostoma Lomaxi*, the Seed of Lyginodendron: Dr. F. W. Oliver and Dr. D. H. Scott, F.R.S.—On the Physiological Action of the Poison of the Hydrophidæ: Dr. L. Rogers.—Preliminary Note on the Discovery of the Pigmy Elephant in Cyprus: Miss D. M. A. Bate.

ROYAL INSTITUTION, at 5.—Hydrogen: Gaseous, Liquid and Solid: Prof. Dewar, F.R.S.

RÖNTGEN SOCIETY, at 8.30.—Exhibition Evening.

CHEMICAL SOCIETY, at 8.—(1) β-Bromonitrocamphor and β-Bromocamphoryloxime. Influence of Impurities in Conditioning Dynamic Isomerism; (2) Spontaneous Decomposition of Nitrocamphor: T. M. Lowry.—The Active Constituents of *Butea frondosa*: E. G. Hill.

LINNEAN SOCIETY, at 8.—The Ingolfiellidæ, fam. nov., a New Type of Amphipoda: Dr. H. J. Hansen.—The Evolution of the Marsupials of Australia: A. Bensley.—Copepoda Calanoida from the Faröe Channel, and Other Parts of the North Atlantic: Rev. Canon Norman, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Applications of Electricity in Engineering and Shipbuilding Works: A. D. Williamson.—Electric Driving in Machine Shops: A. B. Chatwood.

FRIDAY, MAY 8.

ROYAL INSTITUTION, at 9.—Rural England: H. Rider Haggard.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A Possible Cause of the Moon's Obscuration on April 11: Rev. S. J. Johnson.—*Probable papers*:—Observations of Stars Occulted by the Moon during the Eclipse of 1903 April 11: Radcliffe Observatory, Oxford.—Observations of Double Stars made with the 28-inch Refractor: Royal Observatory, Greenwich.

MALACOLOGICAL SOCIETY, at 8.—On the Necessity of Examining and Comparing the Animals before Determining some Species of the Genus Oliva: F. G. Bridgman.—Notes on some British Eulimidæ: E. R. Sykes.—Note on the Occurrence of *Planorbis marginatus*, Drap., and *Limnæa peregeri*, Müll., in the Pleistocene of Bognor, Sussex: Alexander Reynell.

PHYSICAL SOCIETY, at 5.—A Spectroscope of Direct Vision and Minimum Deviation: T. H. Blakesley.—Mathematics of Bee's Cells: Prof. Everett.—The Coloured Map Problem: W. H. Price.—Note on the Construction and Attachment of Galvanometer Mirrors: Dr. W. Watson.

MONDAY, MAY 11.

SOCIETY OF ARTS, at 8.—Mechanical Road Carriages: W. Worby Beaumont.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Cilicia, Tarsus, and the Great Taurus Pass: Prof. W. M. Ramsay.

TUESDAY, MAY 12.

ROYAL INSTITUTION, at 5.—The Astronomical Influence of the Tides: Prof. G. H. Darwin, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—A Contribution to the Study of Double Monstrosities in Fishes: James F. Gemmill.—The Metamorphoses of *Ægeon fasciatus* and *Ægeon trispinosus*: Robert Gurney.—Descriptions of new Species of South American Coleoptera of the Family Chrysomelidæ: Martin Jacoby.

WEDNESDAY, MAY 13.

SOCIETY OF ARTS, at 8.—The Preservation of the Species of Big Game in Africa: E. North Buxton.

GEOLOGICAL SOCIETY, at 8.—On some Disturbances in the Chalk near Royston: Horace B. Woodward, F.R.S.—On a Section at Cowley near Cheltenham, and its Bearing on the Interpretation of the Bajocian Denudation: L. Richardson.—Description of a Species of Heterastraca from the Lower Rhætic Deposits of Gloucestershire: R. F. Tomes.

THURSDAY, MAY 14.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—The Combination of Hydrogen and Chlorine under the Influence of Light: P. V. Bevan.—On the Photo-Electric Discharge between Metallic Surfaces: Dr. W. Mansergh Varley.—The Elasmometer, a new Interferential Form of Elasticity Apparatus: A. E. Tutton, F.R.S.—On the Radiation of Helium and Mercury in a Magnetic Field: Prof. A. Gray, F.R.S., and Dr. W. Stewart; with R. A. Houston and D. B. McQuiston.—Meteorological Observations by the Use of Kites off the West Coast of Scotland, 1902: Dr. W. N. Shaw, F.R.S., and W. H. Dines.

ROYAL INSTITUTION, at 5.—Proteid-Digestion in Plants: Prof. Sidney H. Vines, F.R.S

MATHEMATICAL SOCIETY, at 5.30.—Generational Relations Defining an Abstract Simple Group of Order 32736: W. H. Bussey.—Points in the Theory of Continuous Groups: Dr. H. F. Baker.

SOCIETY OF ARTS, at 4.30.—The Province of Assam: Sir James Charles Lyall, K.C.S.I.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Applications of Electricity in Engineering and Shipbuilding Works: A. D. Williamson.—Electric Driving in Machine Shops: A. B. Chatwood.

FRIDAY, MAY 15

ROYAL INSTITUTION, at 9.—The Origin of Seed-Bearing Plants: D. H Scott, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Etiology of Leprosy: Jonathan Hutchinson, F.R.S.

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