THURSDAY, DECEMBER 18, 1902.

PROF. GIGLIOLI'S COLLECTION ILLUSTRATING THE STONE AGE.

Materiali per lo Studio della "Età della Pietra" dai tempi preistorici all' epoca attuale. Origine e sviluppo della mia collezione. By Enrico Hillyer Giglioli. Pp. 248. (Florence: S. Landi, 1901.)

THE publication of a detailed description of the private collection formed by Prof. Enrico Giglioli is a welcome and important event, and one to which students of archæology and ethnology have long looked forward. Even to those who have not enjoyed the privilege of visiting Prof. Giglioli at home and seeing his treasures, it has been known by many indications that a scientific collection of no ordinary calibre was being brought together by the energetic professor. The actual wealth of material accumulated, as revealed by the present publication, is, however, somewhat startling, and one can but admire the perseverance and success with which he has pursued his hobby. One must refer to his studies and investigations in the fields of archæology and ethnology as a *hobby*, since Prof. Giglioli is a zoologist by profession, his official time being occupied in his professorial duties and his work as director of the important Zoological Museum in Florence. His private collection and the studies connected with it are the results of his leisure time labours, and one may readily infer that he has never indulged in that doubtful luxury "an idle moment." "Chi vive lavorando non ha mai tempo abbastanza," he laments, but he has utilised his available time to the utmost, by methodically devoting his daytime to zoology and his evenings to his collection. In the formation of his very extensive collection, he has kept always in view the definite object with which in 1883 he commenced to collect. His primary aim has been throughout to elucidate so far as possible the "Age of Stone" by means of comparative study; and to this end it has been his endeavour to secure as complete a collection as possible of objects illustrating, not only the life and arts of prehistoric Stone-age man in all countries, but also the conditions of culture of recent savage and barbaric races, whose developmental progress has from various causes been arrested or retarded, and who, therefore, may be regarded as *survivals* from various early stages in the general development of the human race. The bringing together of archæological and ethnological material into close association for purposes of scientific study, to the end that the specimens in the one class may serve to elucidate those in the other, has now long been recognised as of the greatest scientific value. Colonel Lane Fox and Mr. Blackmore were early pioneers in this field of inquiry, and the lessons which they taught still hold good and are increasingly appreciated.

Prof. Giglioli's publication is primarily a descriptive guide to his private collection, drawn up methodically under geographical headings and subheadings. The work is, however, more than a mere detailed catalogue, as its scientific value is enhanced by a running commentary of considerable interest to the archæological and ethnological student. While approving the general form and scope of the work, one cannot but note one serious defect, tending greatly to reduce the utility of this otherwise valuable guide. There is no index to contents. A work of this nature should certainly be furnished with a good index; it should, in fact, be doubly indexed, on the one hand under geographical, and on the other under subject headings. The labour of producing the index would be well repaid by the appreciation with which this important feature would be received, and we may still hope that the author will issue an index in full which may be bound up with the work. There are several very fair illustrations in the text. It would be impossible within the limits of a short notice to give an idea of the richness of this collection. Many of the rarer objects are represented by good series, as, for instance, the New Zealand *hei tiki*, of which there are ten of nephrite, one, perhaps unique, of diorite, and others of bone. There are no fewer than 177 *toki* or stone adzes from the same region. Witness also the remarkable series of hafted stone axes from South America and the thirty-two ceremonial adzes with elaborately carved handles from Mangaia. Among the less rare forms, the numbers run high, and there are no less than 325 stone adzes and chisels from the New Guinea region. Both the art of war and the arts and industries of peace are well illustrated. Many of the uncommon localities which are included in the very comprehensive list of carefully localised specimens are but very rarely represented in even the more important museums, a fact which would of itself place this collection in the front rank. In his descriptions, Prof. Giglioli has given brief notes upon the races and tribes dealt with their geographical position, &c. Wherever possible, he has given the native names of the objects, and details as to manufacture and other points of interest are touched upon, rendering the work (especially if indexed) a valuable book of reference to ethnologists and collectors.

One may readily endorse the hopes expressed by the maker of this remarkable collection that it may eventually find a permanent home in a public museum and be preserved in its entirety. It would be almost a crime to allow the dispersal of a collection so complete and so systematically and laboriously brought together.

EXPLOSION MOTORS.

Les Moteurs à Explosion. By G. Moreau. Pp. xii + 444. (Paris: Libraire Polytechnique, Ch. Béranger, 1900.)

Théorie des Moteurs à Gas. By G. Moreau. Pp. 224. (Paris: Ch. Béranger, 1902.)

THE extraordinary developments which have attended the application of explosion engines to motor vehicles, and the rapidity with which the constructors of these light and powerful engines have carried their designs well within measure of practical perfection, forms one of the most noteworthy achievements of modern engineering.

The time has, however, arrived when practice must be tempered with a sound knowledge of theory, in order that further advances along the existing lines of construction may be achieved.

With this object in view, M. Moreau has compiled two volumes in which the theory of explosion motors and the nature of the combustibles used therein are detailed in a thoroughly clear and systematic manner. The two volumes cover to a certain extent identical ground, but in the earlier work the subject is treated in its widest sense and the mechanical features of the motor vehicle as a whole are freely investigated; while in the later work the author confines himself exclusively to the engine, and here brings the theory of the subject well into line with the latest developments in practice, at the same time indicating the directions in which further improvements may be arrived at.

In the earlier work, the opening chapter is devoted to purely theoretical considerations of motors operating with perfect gases, and the laws regulating the behaviour of such gases under varying conditions of pressure and temperature. The imperfections of the gases actually available in practice are then considered, and the working conditions of the various cycles which may be employed are investigated. A chapter is devoted to the question of the specific heats of gases under various conditions, the question of the rate of the explosion relative to piston velocity, and the losses in actual engines due to throttling at the inlet and exhaust, to the cooling of the cylinder walls and to heat rejected on exhaust; representative diagrams are given and the total losses discussed.

Three chapters are then devoted to questions connected with the mechanical design of engines and motor vehicles, such points as the movements of the piston, connecting rod and crank-pin, valve movements, frictional losses and the strength of materials being fully discussed. All the chief organs of the transmission gear and special items such as axles, wheels, brakes, pneumatic tyres, carburettors and ignition apparatus are dealt with in detail, the author carrying his investigations in this portion of the work far beyond the limits indicated by its title. The nature and properties of the various combustibles which are available for explosion motors are next fully considered, the author remarking with much truth on the extraordinary ignorance amongst constructors on this particular branch of the subject. The work concludes with a comparison of trials of motors and automobiles, and considerations relative to the most suitable cycle to employ, the author advocating a six-stroke cycle —namely, admission, compression, expansion, recompression, explosion, exhaust—the advantages gained being a better mixture, re-heating of the charge after it has entered the cylinder, and abstraction of heat from the walls, which would diminish the loss to the cooling water.

In the more recent volume, which is based on a series of lectures delivered before the Automobile Club of France, the functions of every type of explosion engine which may be employed on a motor vehicle are investigated in a systematic manner. All the most important points in the design of engines, such as the volume of the compression chamber relative to the total cylinder volume, the influence of the walls, of the periods of admission and exhaust, and of the propagation of the explosion are carefully considered.

The concluding chapter, which forms nearly one-third of the volume, is devoted to the nature of the combustibles which may be employed, to the best conditions for the running of an engine and to investigations of the inertia of the reciprocating parts.

The subject in both volumes is handled in the clearest possible manner, and although higher mathematics is freely employed in every investigation, each step is so carefully traced that the author may be followed to his conclusions by all who possess a practical knowledge of the subject of explosion engines.

C. R. D'ESTERRE.

MARIGNAC AND HIS WORK.

Œuvres complètes de Jean-Charles Galissard de Marignac. By E. Ador. Tome i., 1840-1860. Pp. lv + 701. (Genève: Eggimann, n.d.)

THIS edition of the works of Marignac is prefaced by a biographical sketch by his son-in-law, Prof. Ador. From this sketch, we learn that Marignac, a native of Geneva, came of a scientific stock; at the house of his uncle, Le Royer, he early made the acquaintance of distinguished men, of whom there has been no lack in his native town. Prévost, De Candolle and Dumas were frequent guests in Le Royer's pharmacy, and from them young Marignac imbibed that single-hearted devotion to science which so strongly characterised him. He began his career, not as a chemist, but as an engineer; he was a pupil of the École Polytechnique, and later of the École des Mines, at Paris. His talents had so strongly impressed the French authorities, however, that long after he had ceased to be connected with France and had accepted his chair at Geneva, the French Government expressly granted to him the right to keep the title "Ingénieur des Mines," in spite of his having ceased to be a French subject.

In 1840, when twenty-three years of age, he came under the magnetic attraction of Liebig and passed a semester at Giessen; and it bears high testimony to Marignac's genius to find that after that short probation he was offered, and accepted, the much-coveted post of chemist to the porcelain factory at Sèvres. He occupied the position only six months, and on receiving a call to fill the chair of chemistry in the Academy of Geneva (for the University had not at that time been created), he at once accepted, finding his life work in an academic career. As professor there, he lived and died, although in 1878 he withdrew from active teaching. Never robust, he succumbed gradually to an insidious disease, and he died in 1894, after a long and tedious illness, borne with the utmost fortitude. His lectures were models of method and clearness—indeed, these were the characteristic features of all his work—and his modesty, patience and perfect conscientiousness gained for him the esteem of the whole scientific world, testified by the numerous honours which fell to his lot.

His only researches in the domain of organic chemistry, no doubt suggested while in Liebig's laboratory, dealt with phthalic acid and the action of nitric acid on naphthalene. It was at Geneva that he began the series of investigations on atomic weights which have rendered his name famous. The inducement was to test Prout's law; and the ratio between the atomic weights of chlorine, potassium and silver first occupied his attention. His attempts to prepare pure material for experiment led him to undertake numerous subsidiary investigations, some dealing with isomorphism, some with the diffusion and specific heats of salt-solutions. His researches on the double salts of fluorine and potassium with silicon, titanium, tungsten, zirconium, niobium and tantalum, and on the rare earths were all part of his scheme to ascertain the true relations between the atomic weights of the elements. During the forty-five years of his scientific activity, he determined the equivalents of no fewer than twenty-eight elements. Besides these labours, he added to our knowledge of ozone and conducted experiments with Foucault's pendulum.

M. Ador's sketch of Marignac gives an interesting summary of this work, adding also a sketch of the part which he took in developing the modern aspect of chemistry, in adopting the now familiar means of deducing atomic weights from the equivalents determined by analysis.

The present volume is the first of a series of reprints of Marignac's original papers, most of which were published in the "Archives de la Société d'Histoire Naturelle de Genève." The typography and arrangement leave nothing to be desired, and M. Ador has conferred a benefit on his fellow-workers by the labour of love which he has so successfully carried out, and has paid the best possible tribute to the revered memory of his old master. W. R.

A MANUAL OF PHYSICAL GEOGRAPHY.

An Introduction to Physical Geography. By Grove Karl Gilbert and Albert Perry Brigham. Pp. xvi + 380. (London: Hirschfeld Brothers, Ltd., 1902.) Price 5*s.* net.

IT might reasonably have been supposed that there was no field in the United States for a new concise manual on physical geography. Yet the cooperation of one of the most original observers of geological phenomena with the practical teacher of geology in Colgate University has given us a book that we should be very sorry to lay aside. It has, like many of its rivals, been brought unmodified into the English market, where it will appeal to teachers rather than to junior scholars. It would be, indeed, no more suited, with its wealth of American illustration, to European classes than Huxley's description of the Thames Valley would be to dwellers on the Mississippi or the Hudson. But in the continent of North America this little book should take a foremost place. The abundant photographic illustrations are excellent and well chosen. They are not reduced, as in some small text-books, to blurred patches which suggest no natural landscape. The process-blocks seem to us to vary slightly in grain, whereby some of the smaller ones have been brought to a rare degree of delicacy; the sand-ripples on the dunes in Fig. 83 will serve as an example. To name two other suggestive pictures, the contrast of delta and cliff in Fig. 37, and the geognostic details of the "creeping" rock-surface in Fig. 59, are especially well presented.

The style of the text forces the meaning of the illustrations on the reader. The same firmness appears in Mr. Gilbert's "Geology of the Henry Mountains" and "Lake Bonneville," but the effect is there modified by a far more classical terminology. Whether or no joint authorship is responsible for the diction in the present book, the result may be commended as a consistent work of art. These short, direct, eminently English sentences are not easy to write, but are delightful to read and are perfect for their purpose.

The current system of importing American books intact under the name of a London publisher leaves us, even in this case, with such spellings as "oxid" and "sulfur," and such antique words as "sled." While Prof. Brigham writes "bowlder," the joint authors, however, give us our own form, "boulder." "Glen" and "dale" may be, as stated on p. 28, "somewhat poetic" in America, where "gulch" is common, but they are fortunately familiar to every hillman in our islands. Yet these are trifles in a book that appeals to us as much by its style as by its subject.

The authors conceive geography (p. 13) as a comprehensive knowledge of the earth, and their book as a first book of science, similar, we take it, to Huxley's "Physiography." They attract attention to the features seen in any walk across the country, and correlate these with the striking phenomena of high mountain regions, volcanoes, and so forth. On p. 209 the recent eruptions in Martinique are judiciously introduced.

There is little experimental method in the book; the rain-gauge, for instance, is mentioned, without any statement of how a reading can be made in actual practice; the chemical characters of limestone are given, without a hint of how the material may be interestingly dealt with by the pupil. The teacher will, however, supplement the book in these matters, and its clearness of description cannot fail to give him new conceptions. What can be better, for instance, than the remark (p. 279) that "the ocean may be likened to a film of liquid clinging to the outside of a spoon"? We should like to quote some of the more vivid passages, such as the contrast between life in the Alps and in the Rocky Mountains on pp. 191-2. We do not agree with the authors in their discussion of passes in the Pyrenees and Alps, or as to "the somber skies of Germany" (p. 195), when Baden and Bavaria are referred to; but we should probably be far more at fault were we to illustrate—or, as the authors say, "illuminate"—a European text-book by remarks on Georgia or Colorado. GRENVILLE A. J. COLE.

A PICTORIAL ARITHMETIC.

The Modern Arithmetic. Primary and Elementary Grades. By Archibald Murray, A.B. (Harvard). Woodward Series. Pp. 308. (St. Louis, U.S.A.: Woodward and Tiernan Printing Co.)

THIS is a book for the use of a teacher of very young pupils. It is divided into three parts. Part i. (82 pages) is concerned with "number exercises," and consists of thirty-eight lessons, each one of which we may suppose to occupy the child for one day. Each of these lessons consists of a series of questions or directions given to the pupil, such as "hold up seven fingers," "find, by using splints, the half of ten units," &c. A marked feature of this part of the book is the beautiful series of coloured pictures of roses, apples, grapes, strawberries, oranges, finches, redbirds and other interesting objects which it contains, while the interest and curiosity of the young pupil are further secured by a good drawing of a spider and his web, as well as by an excellent picture of a pair of boots.

This part of the book deals, then, as the author says, solely with ideas of comparison, measurement and counting. The extent to which we get in part i. may be inferred from the last two questions or problems in it:—

"A book cost 3 dimes, a pencil 3 cents, and a blank book 3 nickels. How many cents did all three cost? Count from 1 to 30; from 5 to 100 by fives. Count as high as you can by hundreds."

Part ii. treats of the elementary operations—addition, subtraction, multiplication, division—and the meaning of fractions (halves, thirds, quarters, &c.) is gradually unfolded during these operations. The pictorial method is continued in this part, but the pictures are of the geometrical kinds that we get by cutting out and folding paper, so that the measurement of simple areas and the nature of an angle are explained to the little learner. Thus, one of the things here learnt by folding is that the sum of the angles of every triangle is two right angles. Near the end of this part, the nature of a decimal is explained, and the extent to which the pupil has progressed may be seen by the following, taken from the last lesson in part ii.:—

"At the rate of 56 miles per hour, how far will a train travel in 5·6 hours? A bookseller paid $\$9\frac{3}{4}$ for books. How many did he buy if each cost $\$\frac{3}{8}$?"

Part iii. treats of "elementary operations classified," that is, the operations of part ii. are treated more in detail and the philosophy of the subject is expounded. Near the end, the nature of ratio and proportion is explained, instruments, such as a two-foot rule, being employed. Among the terminal problems in this part are the following:—

"Express 9 cu. yd. as a decimal of a cord" (from which we conclude that the author does not anticipate an early introduction of a thorough-going metric system into America); "what is the sum of $\frac{2}{3}$, $\frac{3}{5}$, $\frac{5}{7}$ and $\frac{7}{9}$? The rate of taxation of a city is $1\frac{1}{2}$%. What tax must a citizen pay whose property is assessed at $4500?"

There are no answers supplied to any of the questions (except in two or three instances) throughout the book; it is, as we have said, a guide to the teacher; the young pupils for whose instruction it is intended are not yet *students*.

Of course, the American coinage, with which the questions deal, would require alterations to render the book suitable to English use; but there is no doubt that the author has very skilfully conceived the nature of an effective process of teaching young children, and we think that the exact following of his course and method would prove to be productive of excellent results.

OUR BOOK SHELF.

The Trees, Shrubs and Woody Climbers of the Bombay Presidency. By W. A. Talbot, F.L.S. Second Edition. Pp. xxv + 385. (Bombay, 1902.)

WHEN Sir Joseph Hooker's "Flora of British India," now completed, was undertaken, one of its main objects was stated to be to furnish a basis on which local floras could be constructed. India is so vast, its climatic features are so varied, the economic requirements of its several provinces so diverse, that a general work like that of Hooker needs to be supplemented by local floras in which the special requirements of particular districts can be fulfilled. There is gratifying evidence to show that these requirements are in course of being supplied. There is, for instance, the "Forest Flora of the North-West," by Sir Dietrich Brandis; Sir George King is engaged on the "Flora of the Malay Peninsula"; the "Flora of Ceylon" was completed by the late Dr. Trimen; and General Collett's book on the plants of the Simla district has just been published. We might cite many similar works from the pens of Prain, Clarke, Duthie, Watt, Kurz and others, but enough has been said to show that Sir Joseph Hooker's aim is in process of fulfilment, and that the splendid botanical heritage handed down to us by Roxburgh, Wallich, Wight, Griffith and others is in no danger of being squandered, but is being utilised and extended by the labours of the present race of botanists. When we bring to mind the fact that instruction in botany, at any rate in systematic botany, no longer forms part of the curriculum in the education of medical students, and that complaints have been made as to the lack of interest felt in the subject by the majority of forest officers, this evidence of substantial progress may at least be adduced as a set-off.

The work before us is another instance of the same kind. In form it is modelled upon Hooker's "Flora," in substance it contains a "fairly correct" list of the indigenous ligneous vegetation of the Presidency, together with additional matter relating to distribution, bark, woods and economic products, along with a large number of vernacular names.

The book is in its second edition, and hopes are thrown out that the "next edition" will expand into a handy Bombay forest flora. Actual use in the field or forest, or even in the herbarium, is needed to enable the reviewer to form a complete estimate of the value of such a work. It must suffice to say that the author's method is good, and that it bears the impress of care and accuracy in its production.

La Géologie générale. By Stanislas Meunier, Professeur de Géologie au Muséum d'Histoire Naturelle. Pp. vi + 336; 42 woodcuts. (Paris: Alcan, 1903.) Price 6 francs.

IN this volume, Prof. Stanislas Meunier undertakes, for the International Scientific Library, a presentation of those branches of geological science not already dealt with in his "Experimental Geology" and his "Comparative Geology," published in the same series.

In the introduction to the book, the author defines the ideas which have successively dominated geological theory during the nineteenth century as (1) the cataclysmal views of Cuvier; (2) the uniformitarianism of Lyell; (3) the "actualism" of Constant Prévost; and (4) the "activism," which he regards as the distinctive feature of modern geological thought.

In conformity with this latter point of view, the author then proceeds to discuss the three great causes of change in the earth's crust, namely, the central heat of the globe, the effects of pressure and the influence of the sun's heat. Pursuing this deductive, rather than inductive, mode of treating his subject, the questions next considered are the flexible earth's crust, volcanoes, the action of subterranean and superficial waters, the sea, glaciers, the atmosphere, and vital action. In dealing with each of these subjects, the originality of the author is everywhere manifest, the examples and illustrations chosen being, for the most part, new, and often of a very striking character.

In the second part of the work, which is entitled "Comparative Physiology of Successive Geological Epochs," the effect of the several agencies enumerated during past geological periods is traced, and here we have to notice the same freedom from the stereotyped methods and matter of text-books of geology which we have remarked upon in the earlier portions of the work. Subjects like the cause of the formation of concretionary structures in rocks are treated at considerable length and with much skill, though, it must be confessed, with considerable inequality. On the other hand, many important questions which do not happen to have been made the subject of special research by the author are treated in a superficial manner or altogether passed over, there being little obvious connection between the space devoted to various divisions of the subject and their relative importance.

As a work designed to attract the attention of a general reader and to stimulate the thought of more advanced students, the work is excellent. But it is rather as a supplement to other books on the subject than as an independent treatise that its value is most apparent, for it is wanting in many of those features which are necessary in a work which is designed to give a presentation of the present state of geological knowledge. It is unfortunate that the book is not provided with an index.

The Student's Handbook to the University and Colleges of Cambridge. First Edition, Corrected to June 30, 1902. Pp. 468. (Cambridge: University Press, 1902.) Price 3*s*. net.

IN this volume, the editor has brought together in a concise form all the more interesting facts and methods of procedure which every student should desire to know as he proceeds to the University of Cambridge as an undergraduate. There are twenty-three chapters in all, and each is devoted to special items.

After a short and condensed account of the history of each college, with a list of the officials at present in residence, the reader is made acquainted with the conditions of admission to any particular college, the period of residence, discipline, and an excellent survey of the average expenditure necessary.

The next four chapters are devoted to the details of the conditions and value of the entrance scholarships, exhibitions and sizarships, and the various University and college scholarships and prizes, concluding with a general account of the objects for which the several institutions of the University are utilised.

The handbook then gives useful information on the work of teaching as divided between the University and the different colleges, and then proceeds to bring together all the necessary information for those who are about to qualify for the previous, ordinary B.A. degree, and honours examinations.

After two brief chapters on advanced study and research and examinations for medical students, detailed information is given on the subjects of the B.A. and superior degrees, diplomas and fellowships, followed by useful chapters for candidates for Holy Orders, for the Civil Service and Army, and for teachers.

The final chapters show the facilities for the education of women in the University, an account of the more important outside examinations conducted by the University, concluding with a description of the object and work of the scholastic agency and the Appointments Board.

Bacteriological Technique and Special Bacteriology. By Thomas Bowhill, F.R.C.V.S. Second Edition. Pp. xvi + 324. (Edinburgh: Oliver and Boyd, 1902.) Price 21*s*. net.

As might have been anticipated, a second edition of Prof. Bowhill's book has been rendered necessary by the rapid sale of the first edition.

The book is divided into seven parts, as follows:—Part i., principles of bacteriological technique; part ii., the preparation of nutrient media; part iii., special bacteriology; part iv., the Hyphomycetes; part v., the Blastomycetes; part vi., the Protozoa; part vii., diseases due to undetermined infective agents. The illustrations number 136 and they are all of the highest class. In particular, the photomicrographs, executed by the author and reproduced by the collotype process, are admirable.

The author has the advantage of being, not only a bacteriologist of high repute, but also an acknowledged veterinary expert. It is not surprising, therefore, to find that the diseases of microbial origin, which affect the lower animals as well as human beings, are dealt with in a conspicuously able fashion.

The descriptions of swine fever, swine plague, swine erysipelas, pleuro-pneumonia, contagiosa bovis, broncho-pneumonia bovis, grouse disease, diphtheria and glanders are excellent.

The author has added much new matter to the text, and the book is thoroughly up to date.

Part vii., dealing with diseases due to infective agents of undetermined character, is a specially useful article. As regards rinderpest, the author gives a graphic account of the methods adopted during the recent outbreak of the disease in South Africa. The methods were as follows:—(1) Koch's original bile method; (2) glycerinated bile method (Edington); (3) serum method of Turner and Kolle; (4) defibrinated blood method. Lucid descriptions are given of the best way of preparing the serum, bile and defibrinated blood.

The methods of examining air, water, soil, unsound meat and ice cream are insufficiently discussed, and the bacteriological examination of sewage is apparently not considered at all.

In conclusion, it may be said that no student in veterinary, medical and sanitary science should be without a copy of this excellent manual. That the book will enhance the enviable reputation of the author is beyond question.

Practical Electricity. By J. Hope Belcher. Pp. xi + 165. (London: Allman and Son, Ltd., 1902.) Price 2*s*. 6*d*.

THIS book is intended to be an elementary manual for a laboratory course in practical electricity. It contains instructions for carrying out a number of experiments designed to illustrate the principles of magnetism and electricity. The course is largely modelled on that given by Prof. Ayrton at the City and Guilds Institute. The experiments are well chosen, and the description and instructions seem to us adequate. The student is shown how to tabulate and set out his results, and some useful hints are given to teachers of elementary science as to the conduct of a laboratory class. We notice in one of the experiments the old fallacy of "proving" Ohm's law by a method in which P.D.'s are measured with an electromagnetic voltmeter; it is remarkable how hard this fallacy is to kill. Apart from this and a few minor blemishes, Mr. Belcher's book is a useful little manual.

M. S.

Acht Vorträge über physikalische Chemie. Von J. H. van 't Hoff. Pp. 81. (Braunschweig: Vieweg und Sohn, 1902.) Price 2 Mk. 50 Pf.

PROF. VAN 'T HOFF delivered these lectures in June, 1901, on the invitation of the University of Chicago. As they were intended for a mixed audience, they have a more or less popular character, but in places they would be difficult for anyone lacking special knowledge to follow, without the personal influence of the lecturer. Two lectures each are devoted to the influence exerted by physical chemistry on pure chemistry, technical chemistry, physiology and geology. The treatment is necessarily meagre, but many interesting subjects are touched upon, and to students of science these lectures must prove stimulating and suggestive to a degree.

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.*]

Secular Changes of Climate.

FOR some time past it has been generally believed that the climate of Central Asia was once less arid than at present, but we now know, as Dr. Sven Hedin explained to the Royal Geographical Society on December 8 (p. 134), that important changes have taken place since the Christian era began. He found in the Lob Nor region forests with the trees long dead, traces of a road, ruined villages, coins, manuscripts and other relics which proved the northern shore of the old salt lake (now dry) to have been cultivated and occupied, down to about sixteen centuries ago, by a fairly civilised people. This, I think, implies a rainfall, less inappreciable than the present one, during the earlier centuries of that era, and the change, as he found dead forests, cannot be attributed (as in parts of southern Europe and Syria) to reckless destruction by the hand of man. But, besides this, Sir Norman and Dr. W. J. S. Lockyer have recently proved (in a communication to the Royal Society) a very remarkable correspondence to exist between the distribution of the periodic rains in India, Mauritius and elsewhere and the amount of solar activity, and they have, within the last few days, drawn the attention of the same Society to the fact that zones of abnormally high and low mean barometric pressure exist on opposite sides of the earth and oscillate from the one position to the other in accordance with the periodic small variations of solar activity. Dr. Sven Hedin's discovery apparently indicates a change secular rather than periodic, but may not both operate independently, as in the case of changes due to variations of eccentricity in the earth's orbit and to precession of the axis of rotation? The authors of those papers admit the existence of disturbing causes, some of which may be local, but not necessarily all. Is it, then, possible that these discoveries may afford a clue to the solution of two great geological puzzles—the abnormal temperatures of the Pleistocene and of early Tertiary times? In regard to the former, many now believe that the climate of North Central Europe when the loess was deposited more nearly resembled that of the Caspian steppes, and all maintain that in the Glacial epoch the mean temperature of the whole continent was much below what it is now. How much this was, at the time of greatest cold, is not easily estimated, but a few years ago I attempted a rough approximation. This will be found in a volume of the Contemporary Science Series called "Ice Work" (part iii. chap. i.), and the results (for Europe) are as follows:—Supposing the British Isles to be at their present level (in order to avoid the controversy as to the origin of Boulder-clays and Glacial gravels), the mean temperature of these islands at the present Ordnance Datum would have to be lowered by about 20° F. The same would probably hold good of Scandinavia—at any rate, that would suffice to make either country much more closely resemble a corresponding part of Greenland. In the more central parts of Europe, the problem is rather easier, for here we are undoubtedly dealing with "land-ice." A fall of 18° in the mean temperature would suffice for the Alps; perhaps rather less, 15° or 16°, for the Pyrenees, the Sierras Guadarrama and Nevada, possibly also for the breccia-producing age on the Rock of Gibraltar. A reduction of 18° at most, and more probably about 16° or 15°, would bring back small glaciers to Auvergne, the Schwarzwald, Vosges, Apennines, Corsican mountains, the Caucasus and even the Atlas. I may add that a reduction of 15° appears sufficient to form a great ice-sheet in North America, and that in the southern hemisphere and at Mount Kenya in Africa distinctly smaller change suffices. All these estimates assume the present levels maintained; they may be corrected at the rate of 1° for each 300 feet of elevation or depression. But geologists too often forget that the anomaly of early Tertiary heat is not less difficult to explain than that of Pleistocene cold, for in later Eocene ages the mean temperature of southern England can hardly have been less than 20° above that which it now enjoys. The explanations which have been offered for the Glacial epoch —a different arrangement of sea and land, variations in eccentricity, precessional movements (none of which, in my opinion, are more than partially successful)—cannot be applied to the latter case, so that we seem compelled to seek for some other cause. Variations in solar heat have been already suggested, but hitherto this hypothesis has seemed too much a *Deus ex machinâ*. But as Dr. Sven Hedin's discoveries show that important alterations in climate have been in progress during the last fifteen or sixteen centuries, and Sir Norman Lockyer's researches indicate that comparatively small changes in solar activity produce rather important meteorological effects upon the earth, geologists qualified for the investigation may find it not unprofitable to follow up the clue. T. G. BONNEY.

The Government Grant for Scientific Research.

NOW that the annual advertisement of the Government grant is once more appearing, I should like to call attention to the long interval that elapses between the date appointed for the reception of applications for, and that of making known the distribution of, the grants. The former is fixed for January 31, the latter is some time in May, a period of more than three months. This seems to me to detract somewhat from the value of the grants, for, in certain instances at least, the conditions may have quite altered in so long a time and the possibility of making a particular research have passed away.

King's College, December 8. R. T. HEWLETT.

The Unconscious Mind.

IN a recent review (November 20) of my book on the "Force of Mind," "W. McD." remarks, "The book is vitiated throughout by the insistence upon the part supposed to be played by the unconscious mind."

But a closer attention to the argument would have revealed the fact that, while no stickler for a word and still less an advocate for two minds, the author is compelled to give some name for mental processes unaccompanied by consciousness.

The position of the man who denies any mental processes at all, as distinguished from mechanical, is logical; but the position of the man who distinguishes mental processes (that is, processes which a machine cannot conduct apart from mind) from mechanical, and at the same time will only recognise as mental those accompanied by consciousness, is illogical. The self-same mental process at one time may be conducted in consciousness and at another outside it, and he is therefore on the horns of this painful dilemma. He must either at one time call the process mental and at the other mechanical or "nervous," or he must extend the word "consciousness" so as to include the unconscious. To a psychologist, the consequences of such a theory are deplorable and are described in scathing terms by Prof. James [1] when he depicts the present state of this conservative science; while with a medical man it compels him logically to regard cases of neuromimesis as malingering or fraud because he sees the disease has mental characteristics, and yet cannot, according to the old psychological shibboleth, recognise as mind the unconscious psychic agent. I may say in conclusion that the need for this extension of mind has been felt by none more keenly than by the very psychologists who have refused it. The student of this subject has only to turn to Prof. C. T. Ladd's "Philosophy of Mind," p. 395, and compare it with p. 393; or to Prof. Sully's "Illusions," pp. 266 and 335, to see the existence of unconscious mental actions both asserted and denied in the same book.

These passages and others will all be found in my work [2] on the subject. A. T. SCHOFIELD.

6 Harley Street, W., December 15.

DR. SCHOFIELD objects to my strictures on his extensive application of "the unconscious" as an explanatory principle that solves (for him) all problems of the relations of body and spirit. And he persists in confusing the question of the validity of "the unconscious" with the question of the propriety of so extending the use of the terms "mind" and "mental" as to make them applicable to brain activities that do not involve affections of consciousness. This extended use of the words I myself, following Dr. Bastian, have urged and adopted, but to do this is not to commit oneself to the hypothesis of "the unconscious mind." Dr. Schofield's use of this phrase implies the assumption of a factor in mental life that is neither neural process nor conscious process, but an utterly unknown, unknowable and mysterious third agent, more or less intervening between the two

[1] Prof. W. James, "Psychology," p. 468.
[2] Dr. Schofield, "The Unconscious Mind," 2nd edition. (Hodder and Stoughton.)

known processes. This I hold to be a radically vicious hypothesis, not merely because it is unverifiable (for, in spite of the dictum of J. S. Mill, that appears to be an insufficient ground for condemnation), but (1) because it invokes an agency of an absolutely unknown order, (2) because it is not necessary and does not help us to give a consistent description of the facts, (3) chiefly because it serves merely as a cloak disguising our ignorance and must tend to make those who adopt it content to remain ignorant. Dr. Schofield's position seems to be based solely on the following argument:—

The human organism exhibits activities that cannot be shown to be accompanied by corresponding states or processes of consciousness, but which nevertheless display so great a complexity and nicety of adjustment of means to ends that we cannot suppose them to be carried out by the agency of neural processes only; therefore we must assume an agent that plays a part similar to that which we assign to consciousness, but differing from it merely in not being consciousness. But when many of our leading thinkers accept the view so clearly enunciated by Huxley in his essay on "Animal Automatism," the view, namely, that all human activities are carried out by the agency of neural processes without the causal intervention of any other factor, consciousness being an epiphenomenon merely, why should Dr. Schofield believe himself competent to draw a line at any particular degree of complexity of behaviour, saying "So much can the unaided neural processes accomplish, but no more."

W. McD.

THE UNIVERSITY OF LIVERPOOL.

IN 1879, Dr. Lightfoot, speaking at a prize-giving in Liverpool, described as seen in a dream its future University College. The speech had no small influence in securing the foundation of the College, and twenty-three years have done much to realise the dream.

The progress of University College has been most striking; it started in 1881 with seven professorships and three lectureships. Now there are twenty-one professorships each endowed with the sum of 10,000*l.* and one temporarily endowed. The total number of professors, lecturers and assistants is seventy-two, and the value of the endowment about 226,000*l.*

Practically all of this has been given by citizens of Liverpool, much in single sums of 10,000*l.*, for the founders, inspired by Mr. Rathbone, were wise men, and realised that they were providing for a large need and must do it on a large scale.

The value of the College site and buildings already erected is about 280,000*l.*, while 50,000*l.* from the fund recently raised is to be spent immediately in further buildings. For scholarships, prizes, the maintenance of laboratories and of the Day Training College, about 60,000*l.* has been invested; a capital sum of more than 600,000*l.*, contributed in twenty-three years by Liverpool benefactors for the advancement of learning and for the education of their townsfolk.

Besides this, large sums are given voluntarily each year for annual expenditure. The city shows its interest in a practical manner by the grant it makes towards certain of the technical classes, while the fees received from students last year reached 13,000*l.* These results, though they may seem small compared with some of those achieved through individual generosity in America, are splendid. The Bishop's dream is nearly realised.

Now the men who have done this come forward and say that it is necessary for the future success of their work that the union which exists between the three colleges of the Victoria University should be dissolved, and that Liverpool should have its own University. Can anyone gainsay their right to speak or urge that they are not the best judges of their case?

They speak with no uncertain voice. The Education Bill transfers to the City Council the control of education in the city, and the Council is of opinion that a University of Liverpool is necessary as the keystone of the arch it intends to build; it has already received power to raise a rate for university education if a Charter is granted to University College, and it intends to do it. It is inconceivable that that Charter should be refused, that the Government, which has indicated its wise desire to leave freedom wherever possible for the development of education according to local needs, should refuse the request of one of the greatest of the local authorities of the country, the Corporation of Liverpool, to complete its work by establishing a "great university for a great city." These were the words used by Mr. R. B. Haldane at a city dinner in Liverpool some four years since; it was clear from their reception then that the ideal he put forward appealed strongly to the representative gathering which he addressed, and in the joint petition of the City and University College for a Charter which is now before the Privy Council we have the outcome of his words.

The case is one which carries conviction as it is read. The grant, it is urged, would greatly stimulate the development and increase the influence of University College and other institutions for the promotion of higher education in the city; it would bring higher education into closer connection with the professional and commercial life of the city; it would provide a true university education for many who cannot leave home to obtain it—the promoters urge with success the distinction between education in a university college, a part of a federal university, and that in a university—it would stimulate research by multiplying in the proper places the centres at which this can be carried on, and, having regard to the inadequate provision of the higher forms of education in England relatively to foreign nations, would be for the benefit of the nation as a whole.

Each of these claims is substantiated by solid facts.

The success of the movement will mean the dissolution of the Victoria University in its present form.

To this, Owens College, the predominant partner in the federal University, has given a ready consent; the two great cities of south-west Lancashire are at one in the belief that each may well be the centre of an independent university, and the case for Owens College is in many ways stronger than that for Liverpool. Yorkshire College, on the other hand, wishes to retain the present system. The financial position of Yorkshire College is much weaker than that of her sister colleges; Mr. Lupton at Leeds in January last said, when speaking of the number of its students, "It will compare favourably and creditably with the other two colleges of the University, but in its material assets it is ludicrously wanting. In the capital of the College, the assets are between 250,000*l.* and 300,000*l.*, but the money has been spent on buildings, apparatus, &c. Of invested capital, we have not quite 39,000*l.*, the income of which goes to the annual expenditure of the College."

At present, then, Yorkshire College is less fitted than the others to become a university, hence in part its dislike at being left alone. But Yorkshiremen are quite able, as was stated by the Principal of the College and the Bishop of Ripon at the same meeting, to create a university of their own if the need for it arises, and it will be found in Leeds no less than in Liverpool that a great university is a great power for good and for advancement.

To Liverpool and Manchester, the failure of the petition would be disastrous; it would curb enthusiasm, it would check the flow of benefactions for education, it would discourage men whose whole heart is in the great work they have set themselves to do, to build in each of these two cities a university which they feel is needed for the highest training of men and women in whose hands the future rests; it would compel two responsible bodies who have each decided that it can best perform its allotted duties separately to endeavour to struggle on in a union which they feel is hopeless.

All this is clear to anyone reading the case presented, so clear that of the issue there can surely be no doubt.

THE MINNESOTA SEASIDE STATION.

AMONG newer American establishments for the study of marine biology, the Minnesota Seaside Station has awakened considerable interest. It is upon British soil, being situated about sixty miles north-west of Victoria, British Columbia, just at the entrance of the Straits of Fuca. The site was chosen after a careful reconnaissance of the Pacific coast, both Canadian and American, and presents some remarkable advantages. So far as accessibility is concerned, it may be reached from Seattle, Port Townsend or Victoria, and commands, not only the outer waters of the ocean, but the region of Puget Sound as well.

FIG. 1.—Buildings of Minnesota Seaside Station as seen across Station Cove. The large laboratory building is not shown, but stands immediately to the right of the smaller building. The buildings face nearly south.

The physiographic features of the shore in the vicinity of Port Renfrew, Vancouver Island, the nearest harbour to the Station, are extraordinarily favourable for the development of its special and characteristic work. The country rock is a tilted slate, cut by dykes of diabase and overlaid by millstone grit and sandstone. The bold promontory, just north of the Station, is of sandstone covered with glacial drift. The very broad shelving shore of sandstone is dotted with a great number of pot holes, worn by glacial boulders and ironstone concretions from the country rock. These pot holes vary in size and depth from little shallow saucers a few inches across to huge wells and cisterns many yards in diameter and often twenty feet or more in depth. Hundreds of such pools between tide marks serve as natural aquaria. Each has its characteristic distribution of plants and animals. For this reason, the Station shore is astonishingly rich in types of oceanic fauna and flora. Within a couple of miles, the formations change, and no other place upon the entire Alaskan, British Columbian or Californian coast is known to be so favourable for naturalistic study and research as that where the Minnesota Seaside Station has been built.

The thing of most importance about a seaside station is the sea. Minnesota, occupying a mid-continental position, might send its students with equal ease to the Atlantic or to the Pacific. It seemed, however, that a rallying point upon the Pacific would be the more inspiring. The eastern shore is already somewhat hackneyed and over civilised, so that the distractions of village life, golf, yachting and society may, in some circumstances, interfere with the free and genuineactivities of a station. It is undeniable that, when a laboratory by the sea has acquired the appurtenances and refinements of a highly organised institution, something is lost on the side of Nature to counterbalance the gain in comfort and conventionality. The Minnesota Seaside Station, two thousand miles distant from the laboratories of the University of Minneapolis, behind the great plains and mountain ranges, sixty miles from any considerable settlement, free from the influence of morning newspapers, daily mails and inquiring tourists, has for its paramount source of interest and principal spring of enthusiasm the sea, and the sea alone.

From its site, three miles south of the harbour of Port Renfrew, visited four times a month by a little coasting steamer belonging to the Pacific Navigation Co., the Seaside Station looks out directly towards Cape Flattery. To the right roll the swells of the open Pacific. To the left, across the blue straits, rise, peak upon peak, the Olympics with their glistening glaciers, untrodden summits and eternal snows. There are few more beautiful spots in northern latitudes. One feels the magic of the mountains, the forest and the sea, and not to be a naturalist in such an environment is scarcely possible.

FIG. 2.—Group of students holding an extended specimen of the Giant Kelp, *Nereocystis priapus*. The holdfast is seen hanging down on the right and the leaves are held upon the left.

During its first season, there were twenty-nine in attendance at the Station. In 1902, the number rose to thirty-eight. Most of the party met at Minneapolis and journeyed to the coast in chartered cars which were cut off for several days in the mountains both going and returning. This enabled those who wished to climb some of the peaks in the vicinity of Banff, Laggan and Glacier. The whole region along the Canadian Pacific Railway from Banff to Mission abounds in problems for alpinists, and there is no better climbing in Europe or North America than that near Laggan, where Mounts Temple, Victoria, Hector, Hungabee and Lefroy, among the rest, are a perpetual challenge to the venturesome.

At the Minnesota Seaside Station, three buildings have been erected. One, a large log boarding house some thirty by sixty feet upon the ground and two storeys in height, serves as a camp. A smaller one-storey log house is used as a laboratory for zoology, and a two-storey frame building, twenty-four by forty feet in dimensions, is occupied by elementary and advanced students of botany. Lecture courses last year were conducted for the most part out of doors—either in the forest or upon the rocks by the sea. Indoor talks in connection with microscopic study of fresh material or around the fireplace in the large living room after dinner were also features of the work.

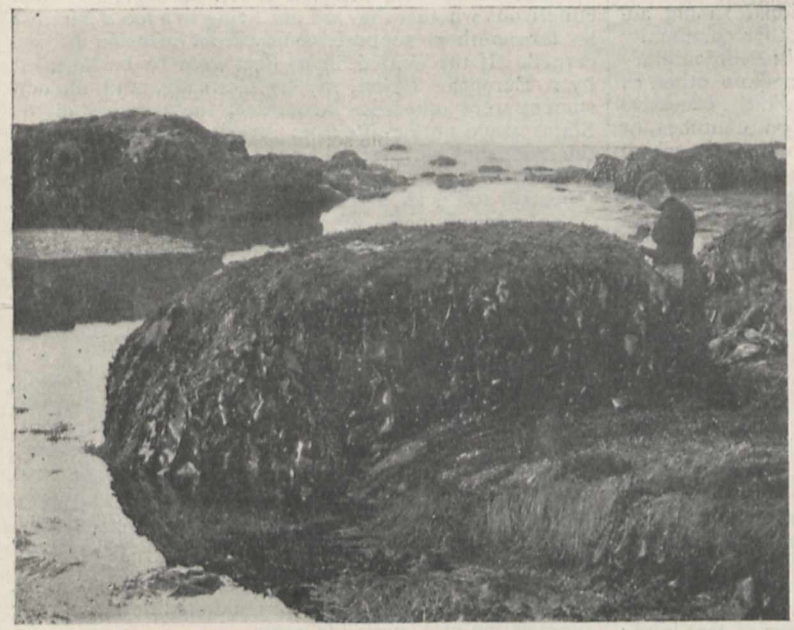

FIG. 3.—Kelp-covered rock at low tide showing specimens of Alaria, Egregia and Halosaccion in characteristic attitudes. *Phyllospadix scouleri* appears in the foreground.

Several papers, both of a scientific and popular nature, and based upon observations or research at the Minnesota Seaside Station, have already been published. Some of these have appeared in "Minnesota Botanical Studies" and others in "Postelsia," the year-book of the Station, the volume of which for 1901 has recently come from the press.

Many useful phases of marine biological work have not yet been, and perhaps never will be, developed at Port Renfrew. There is an absence of dredging apparatus. No pumps, conduits or artificial aquaria have been installed, nor are the buildings supplied with electricity or gas. A serviceable steam launch is still one of the dreams of the future. Unlike most other marine stations, the one on the Straits of Fuca has never received any gratuities whatever from Government, institution, society or individual, but has been built and modestly equipped entirely through the cooperation of those who have enrolled themselves among its members. It is, in fact, organised somewhat like a club, and while unable to compete with the older stations in expenditure, nevertheless derives a certain advantage from its community of interest and independence.

For the use of the illustrations which accompany this article, we are indebted to the *Popular Science Monthly*.

MR. CARNEGIE'S ST. ANDREWS ADDRESS.[1]

MR. CARNEGIE'S rectorial address at St. Andrews is an interesting study in the psychology of the typical business man of modern times, as well as a memoir on the conditions of great business, which people must read for the sake of the shrewd and acute remarks themselves, such as no statesman or economic student can afford to overlook. The address is written exclusively from the point of view of a great industrial chief who has availed himself to the full of the conditions of business in the most favoured and wealthy community which the world has yet seen—that of the United States. He has observed and seized the great opportunity for the concentration and development of industry on a large scale which the United States has afforded. A large area of complete internal free trade, and an active, vigorous and rapidly growing population throughout this area, have given the United States manufacturer for many years an unrivalled opportunity for colossal arrangements, involving the cheapening of cost by means of subdivision of labour and the institution of mechanical and automatic processes wherever hand labour could be superseded. This opportunity, properly used, has been the occasion of Mr. Carnegie's gigantic fortune, and it is accordingly natural that he should speak of all business as conforming to this type, so that a community like the United States supplies the model for great manufacturing business in future. The cheapness of production once established, it is assumed, will enable the United States to be the most successful competitors internationally, and Britain accordingly will take a second place in future, if not a third place, with Germany second. Naturally also, Mr. Carnegie regards the protectionist policy of the United States as having contributed to this result and given the United States manufacturer the monopoly of his large home market. Nor is it surprising to find the ordinary American idea about the economic effect of military armaments put forward by Mr. Carnegie as explaining the backward state of Europe compared with the United States. The ideas come from his environment and history, and the result of their combination with Mr. Carnegie's own shrewd observations is the present most instructive address.

The interest, however, is mainly psychological. Economically, there is nothing really new and true. Adam Smith explained long ago the economic gain of the subdivision of labour, the condition of manufacturing on a large scale, while the practical value of manufacturing on a large scale and for the largest possible market was exemplified first of all, not by the American, but by the Lancashire manufacturer, who had the home market of

[1] A rectorial address delivered to the students in the University of St. Andrews, October 22, by Andrew Carnegie. (T. and A. Constable, 1902.)

the British Empire at his command as well as the general market of the less civilised nations of the earth. Where the United States has gone ahead has been in the special business of iron and steel, a development required by the more special conditions of industry in the United States, and not in every business requiring large markets. *Pace* Mr. Carnegie, also, it does not appear that the protectionist policy of the United States has favoured the development of great manufacturing. In iron and steel especially, the advance was favoured by naturally high prices attending the great demand for iron and steel, which was always producing a shortage in the old countries of Europe, especially Great Britain, such as we now witness in the United States itself. This recurring shortage, apart from the United States tariff, must infallibly have developed naturally the iron and steel industry of the United States, though Mr. Carnegie and others might have realised smaller fortunes than they have done in the process. As to Europe being overweighted in any way by military armaments, there is an obvious want of connection between the effect and the alleged cause. Extravagant expenditure is, of course, one reason why one community or individual should accumulate wealth at a lower rate than another community or individual, but extravagant expenditure on military objects has precisely the same effect, and no other, as any other kind of extravagance. Overbuilding, excessive outlay on dress or carriages, outlay on churches or theatres, are, or may be, forms of expenditure in which nations or individuals may indulge to their hurt as well as in armies and navies. Nor can the American community throw stones at any other community in this matter, as extravagance is one of the American's special vices, and there is one conspicuous case of this extravagance in the remarkable pension list which has grown up since the Civil War, and affects them economically much as a great debt or great expenditure on army and navy would affect them. Besides, when analysed, however great the outlay may be, the maintenance of armies and navies does not add to the cost of production in other industries in any country. The expense of these "luxuries," let us call them, is a deduction from the earnings of the community, so that there is, *pro tanto*, less to spend on other things; but the cost of producing these other things is not concerned.

While making these observations on Mr. Carnegie's theories, we cannot but agree with his view that the primacy of Great Britain as an economic unit is passing to the United States. The economic force of the United States is obviously the greatest single force of that kind; and the preponderance of the United States is increasing. This is no new idea. Mr. Gladstone and many others long ago pointed out how modern industrial forces were tending. People should weigh well, however, what Mr. Carnegie has to say in his own department as to the approaching exhaustion of the iron ores of Great Britain, a matter of common knowledge to those interested. Great industrial changes must follow this impending change. More interesting and surprising even is Mr. Carnegie's anticipation as to the exhaustion of the United States supplies themselves. "Even the United States," he says, "has a proved supply of first class ore only for sixty to seventy years, and a reserve of inferior grades which may keep her supplied for thirty years longer, say for a century in all, unless the rate of consumption be greatly increased. The enormous extent of territory in the republic over which ore can hopefully be looked for encourages the belief that new deposits are sure to be found." Germany, it is added, has the most enduring supply, although its ore is not nearly so rich as the American. All this points to great economic changes even more far reaching than what is implied by the exhaustion of iron ore in Great Britain only.

With many other observations, there must also be agreement, especially as to the importance of home markets, the diminishing importance of foreign trade and the like. There is, in truth, no distinction in essence between home and foreign markets. The proper distinction is between near, less near and distant markets which are all in their nature the same, the availability and accessibility in each case varying with every variety of goods and every variation in the conditions of transportation. Other things being equal, there is, of course, more exchange between near than between distant markets, and there are many goods and services where the exchanges are necessarily local.

The one weak point in the address is really what is said about the effect of European armaments, upon which comment has already been made. It may be admitted that, so far as there is insecurity and fear of invasion, Europe is politically less advantageously placed than the United States, and European business is, *pro tanto*, checked. But in itself, military expenditure is no worse than any other expenditure, and so far Europe is not handicapped in the race. We should like to throw out also for the consideration of Mr. Carnegie and other Americans whether they are not living in a fool's paradise so far as their supposed safety from invasion is concerned. If the United States fleet were to be defeated by a European Power, say by Germany, and circumstances were otherwise favourable, the territory of the States would not be safe from invasion. Descents upon the coast such as England was able to make in the War of Independence and in the war of 1812 might be repeated, and even a more serious invasion attempted. The American boast of their freedom from European militarism is one which it is not quite wise or safe to make.

R. G.

THE JUBILEE OF LORD LISTER.

ON December 9, 1852, just fifty years ago, Joseph, now Lord, Lister passed his examination and was admitted a Fellow of the Royal College of Surgeons, thereby becoming a member of the medical profession. The jubilee of such an event abroad would have been made the occasion of a congratulatory address and of the compilation of a notable "Festschrift" to the honour of the great master of antiseptic surgery. Here we do things differently, and it has been reserved for the *British Medical Journal* to issue a Lister Jubilee number, in which eminent men of various nationalities give their appreciation of Lister's life-work.

Von Bergmann, of Berlin, contributes some remarks upon the use of iodoform gauze in operations upon the cavities of the body; Lucas-Championnière, of Paris, writes on Listerian methods of the present and of the future; and Oscar Bloch, of Copenhagen, upon the antiseptic system in Denmark; while von Mikulicz-Radecki, of Breslau, gives a contribution upon the treatment of fractured patella. Among the British contributors, Ogston, of Aberdeen, and Hector Cameron, of Glasgow, discuss the influence of Listerism upon military surgery and upon the evolution of modern surgery respectively, Watson Cheyne, of London, discusses Listerism and the development of operative surgery, while Annandale, of Edinburgh, writes pleasantly of early days, and Chiene, also of the Scotch capital, gives an account of the Edinburgh Royal Infirmary from 1869 to 1877—that is to say, during the time Lister held the chair of clinical surgery there. It is a notable number devoted to a notable man.

Although it is as the founder of antiseptic surgery that Lister's name will descend to posterity, his other achievements must not be forgotten. Into surgery he introduced many valuable methods of operative procedure and also the use of the catgut ligature, and his contributions to the pathology of inflammation, the nature and mechanism of blood coagulation and the bacteriology of fermentation would alone entitle him to a place among the "Scientific Worthies." A characteristic trait of a great personality must have struck all those who had the privilege of working under Lister; this was his intense regard for the welfare of his patients. The writer well remembers Lord Lister's distress at some mishap which befell a patient, unforeseen at the time, but which, in the light of after events, might have been preventable.

Lord Lister's great experience has been called into requisition at least twice in recent years to aid the deliberations of those in whose hands the health of His Majesty the King has been entrusted, once when he was Prince of Wales and secondly in his recent severe illness. Lastly, as chairman of the King's Hospital Fund, he still continues his benefits to humanity. His various contributions to science and the honours bestowed upon him have already been detailed in NATURE, but it may be mentioned that this year he has been the recipient of the Copley medal of the Royal Society and of the Order of Merit.

R. T. HEWLETT.

NOTES.

THE First Lord of the Treasury has appointed a committee to inquire and report as to the administration by the Meteorological Council of the existing Parliamentary grant, and as to whether any changes in its apportionment are desirable in the interests of meteorological science, and to make any further recommendations which may occur to them, with a view to increasing the utility of that grant. The committee will consist of:—the Right Hon. Sir Herbert E. Maxwell, Bart., M.P., (chairman), Mr. J. Dewar, M.P., Sir W. de W. Abney, K.C.B., F.R.S., Sir F. Hopwood, K.C.B., Board of Trade, Sir T. H. Elliott, K.C.B., Board of Agriculture, Dr. R. T. Glazebrook, F.R.S., Mr. T. L. Heath, Treasury, and Dr. J. Larmor, F.R.S. Mr. G. L. Barstow, of the Treasury, will act as secretary to the committee.

ANNOUNCEMENT has now been made of the Nobel prize awards this year. The awards include the following for science:—Medicine, Major Ronald Ross, School of Tropical Medicine, Liverpool; chemistry, Prof. Emil Fischer, Berlin; physics, divided between Prof. Lorenz, Leyden, and Prof. Zeeman, Amsterdam.

DR. BORDAS, assistant-director of the Paris Municipal Laboratory, has been awarded the Lacaze prize for his investigations in connection with typhoid fever. The prize is worth 400*l*.

DR. T. K. ROSE has been appointed chemist and assayer in the Royal Mint, in succession to the late Sir W. C. Roberts-Austen, K.C.B., F.R.S.

DR. SVEN HEDIN delivered an address before the Royal Scottish Geographical Society at Edinburgh on Tuesday. Sir John Murray, who presided, announced that the council had awarded Dr. Hedin the Livingstone memorial gold medal for the distinguished services which he had rendered to science by his explorations in Central Asia.

WE regret to see in the *Athenaeum* the announcement of the death of Prof. J. Wislicenus, professor of chemistry at Leipzig University.

COLONEL SIR T. H. HOLDICH has been appointed Knight Commander of the Order of St. Michael and St. George for services in connection with the Chile-Argentine Boundary Tribunal.

ACCORDING to the Paris correspondent of the *Times*, Prof. Lacroix, the head of the French Scientific Mission at Martinique, has reported that owing to the undermining of the point of the cone formed in the crater of Mont Pelée, masses of material have rolled down in the direction of White River, completely choking it. The ashes which filled the lower valley at a distance of six kilometres from the crater had still a temperature of more than 100° C. a week after they had been projected from the volcano.

WE regret to have to announce the death of Dr. Antonio d'Achiardi, of Pisa, in his sixty-fourth year. Dr. d'Achiardi was born and educated at Pisa, and had occupied the chair of mineralogy and geology in the University there since the year 1876. He was the author of treatises on both mineralogy and petrology, and published numerous memoirs, many of them relative to the mineralogy of Tuscany. Prof. d'Achiardi was an honorary member of the Mineralogical Society of this country.

THE following announcements of deaths, from yesterday's *Times*, will be read with regret by many men of science:—Prof. Millardet, professor of botany, first at Nancy and afterwards at Bordeaux, where his researches checked the ravages of the phylloxera.—Privy Councillor von Kupffer, professor of anatomy at the University of Munich.—Major Walter Reed, one of the foremost bacteriologists and pathologists of the United States. During the Spanish war he was a member of the board to investigate typhoid fever in the army. Later, he made several trips to Cuba and was on duty in Havana studying the diseases of the island as a member of the board to investigate the causes of yellow fever. As the result of investigations, the conclusion was arrived at that yellow fever is conveyed by a certain variety of mosquito, which, by its bite, introduces the disease into the blood of non-immunes. Sanitary measures for the destruction of the insect and for the screening of infected persons were at once put into effect in Havana, with the result that for more than a year no case of yellow fever has been developed there.

THE thirtieth annual dinner of the old students of the Royal School of Mines will be held on Tuesday, February 3, 1903, at the Hotel Cecil. The chair will be taken by Mr. A. C. Claudet. Tickets can be obtained from Mr. D. A. Louis, 77 Shirland Gardens, London, W.

THE fifth International Congress of Applied Chemistry will be opened in Berlin on May 31, 1903. Prof. Clemens Winkler will be honorary president, and Prof. Otto N. Witt, the president of the German committee, will occupy the chair. Dr. H. T. Böttinger is now actively engaged in securing the cooperation of British men of science. There will be twelve sections in all, at which every branch of pure and applied chemistry will be discussed.

THE annual meeting of the Geographical Association will be held on Friday, January 9, 1903, at 3.30 p.m., in the College of Preceptors, Bloomsbury Square, London, W.C. The president, Mr. Douglas W. Freshfield, will be in the chair, and will give an address. There will also be an address on the Australasian Commonwealth, by Sir John A. Cockburn, K.C.M.G., and an exhibition of maps, views and diagrams by lantern projections, illustrative of the Ordnance Survey maps, by Mr. A. W. Andrews.

THE success of the general meeting of the American Philosophical Society, held last April, established most satisfactorily the claim that the interests of useful knowledge in the United States may be greatly promoted by holding an annual general meeting of the Society. It was therefore decided to hold a second meeting, and in accordance with this resolution the meeting will take place on April 2 and 3, 1903. A strong and representative committee was appointed to make the necessary arrangements, the chairman being Prof. George F. Barker, and secretary Mr. I. Minis Hays.

THE commission appointed a year ago by the legislature of New York to investigate and report upon the advisability of the State establishing an electrical laboratory will probably report, says the *Electrical World*, in favour of establishing such an institution, which will also serve as a standardisation bureau. It is reported that the commission has learned that the amount of capital in New York State directly interested in the development and use of electricity is 1,680,590,290 dollars, made up of 217,974,695 dollars, representing the capitalisation of the companies engaged in the manufacture of electrical apparatus, and 1,462,615,595 dollars, the capitalisation of the companies involving the use of electricity.

A PETITION to be presented to the council of the Chemical Society is now being circulated among Fellows of that body for signature, in which it is suggested that the council should take the opportunity afforded by the approaching resignation of the senior secretary, Prof. W. R. Dunstan, of limiting the period during which this office may be held, and so afford to the younger Fellows of the Society "an opportunity of gaining experience in this honourable official position." It is pointed out that such a limitation is already in force at the Royal Society.

A MEETING of the Imperial Vaccination League was held on Friday last, under the presidency of the Duke of Northumberland. The report was read by Mrs. Garrett Anderson, and it stated that the League would supply literature on the subject of vaccination for distribution, and that a body of lecturers would be organised to give addresses on the subject of smallpox and the protection which vaccination affords. In proposing the adoption of the report, the chairman referred to the extremely small fear of complications arising from vaccination now that calf lymph is used. The Bishop of Stepney, in seconding, remarked that educational work by the League was necessary in order to counteract the influence of societies opposed to vaccination. Sir Michael Foster, in moving the election of the executive committee, stated that an important point to consider was whether the sanitary authorities were the right ones to administer the Acts relating to the health of the people.

AT the annual meeting of the Yorkshire Naturalists' Union, held at Hull on December 10, Mr. W. Denison Roebuck was presented with a handsome testimonial in recognition of his past services as secretary of the Union and editor of the *Naturalist*. The presentation took the form of a beautifully illuminated address, in book form, and a clock and bronzes. References were made by many speakers to the ability with which Mr. Roebuck had worked in the interests of the Union. The presidential address was afterwards delivered by Mr. P. F. Kendall, his subject being "Problems in the Distribution of Animals and Plants." The new secretary is Mr. T. Sheppard, of the Municipal Museum, Hull, and the *Naturalist* will in future be edited by Mr. Sheppard and Mr. T. W. Woodhead, of Huddersfield. The president for 1903 is Mr. Roebuck, and Mr. J. H. Howarth is the treasurer.

THE Zoological Society of New York has acquired the Aquarium, which stands in Battery Park, New York City. It has been transferred to the Society by the City upon terms which provide for the entire control and management of the Aquarium by the Society and for an adequate maintenance of it by the City. The Society has appointed Mr. Charles H. Townshend, late of the United States Fish Commission, as director of the Aquarium. With him will be associated an advisory committee of experts, and the Aquarium will be managed by the Society in the same manner as the Zoological Park.

DR. J. W. B. GUNNING, Director of the Pretoria Museum and Zoological Gardens, sends us a long list of the additions to the menagerie of that institution which have been made during recent months. Amongst them is the celebrated lioness "Beauty," commonly called "Kruger's Lion," which was originally presented by the late Mr. Rhodes to the Pretoria Gardens in 1899 and returned to the donor by Mr. Kruger's orders. Mr. Rhodes then gave it to the Zoological Society of London, in whose gardens it remained for two years. At the special request of the authorities at Pretoria, the lioness was sent back there in July last, Mr. Rhodes's executors having signified their approval of this being done.

BY the death of Mr. Henry Stopes, the science of prehistoric archæology has lost an enthusiastic student and an indefatigable collector. By profession Mr. Stopes was an engineer, and he more particularly interested himself in Palæolithic implements viewed from the standpoint of a practical mechanic. He amassed an enormous collection of Palæolithic implements of all sorts, rightly judging that long series were all important in scientific study. He held that more could usually be learned from a rude or from an imperfect or unfinished implement than from the typical finished product, and thus he eagerly collected the "wasters" and the ruder and unfinished forms. In a short paper published in the *Journal* of the Anthropological Institute (vol. xxix., 1899, p. 302), he announced the discovery of *Neritina fluviatilis*, with a Pleistocene fauna and worked flints in high terrace gravels of the Thames valley, and in the following volume of the same *Journal* (p. 299) he published a paper on "Unclassified Worked Flints," illustrated by numerous specimens.

THE following candidates have been nominated for the Fellowship of the Reale Accademia dei Lincei:—As corresponding Fellows, Profs. Beccari, Donati, Lustig, Parona, Pascal and Venturi; as foreign Fellows, Profs. Lorentz, Thalèn, de Vries, Wiesner and Zeuthen. The Academy has been singularly unfortunate in its loss during the summer recess of the four ordinary Fellows General Annibale Ferrero, Prof. Adolfo Targioni-Tozzetti, Prof. Alfonso Cossa and Prof. Riccardo Felici, one corresponding Fellow, Prof. Magnaghi, and, on the list of foreign Fellows, Profs. Faye and Virchow. General Annibale Ferrero took a prominent part from the outset in the work of the International Geodetic Association. He held office in 1872 as head of the geodetic division of the Italian Military Topographical Institution, in 1893 as director of the Military Geographical Institution, from 1873–83 as secretary, and from 1883 as president, of the Royal Geodetic Commission for Italy, from 1891 to 1897 as vice-president of the Permanent Commission of the International Geodetic Association, and from 1897 until his death as president of the Association itself. Prof. Adolfo Targioni-Tozzetti started his career as a botanist, but in 1866 was elected to the chair of comparative anatomy and invertebrate zoology at Florence. In 1875, he was appointed director of the newly-formed Department of Agricultural Entomology at Florence. His most important writings are on entomological subjects, and include papers on the luminous organs of the Italian "lucciole," the classification of the Orthoptera and the vine diseases oïdium and phylloxera. Alfonso Cossa was first assistant lecturer at Pavia in materia medica and botany; he subsequently held an appointment there as professor of chemistry and director of the Technical Institution; from 1866 to 1871 he was principal of a new technical institution at Udine, and then at Turin he held various posts, culminating in 1882 in a chair of chemistry in the Engineering School of Valentino. His writings deal with agricultural chemistry, mineralogy and electro-chemistry, and his name has been perpetuated in the mineral Cossaite.

MR. E. ERNEST LOWE, curator of the Plymouth Museum and Art Gallery, sends a description and sketch of a portion of a mammalian tooth found by Mr. F. Leslie Sara, of Yelverton, in a cave in the Mendip Hills, Somersetshire. Mr. Lowe has identified the object, the greatest length of which is nearly six inches, as the terminal portion of one of the lower canine teeth of *Hippopotamus amphibius*. "The grinding surface of the tooth," he remarks, "is closely striated, and in the centre the striæ are so close and deep as to form a distinct groove, whereas all the recent hippopotamus teeth I have been able to examine have a *smooth* grinding surface. At the point of the tooth, the enamel is chipped as if from a blow. At first sight, the specimen appears to have been cut from the complete tooth with a modern saw, but I am assured it is exactly as found. The cut end was exposed on the surface of the clayey ground." Mr. Lowe suggests that the tooth is a prehistoric flint-flaker or axe-head of a unique character, but an authority to whom we have submitted the matter informs us that *fossil* hippopotamus tusks exhibit a structure exactly similar to that described by our correspondent. It is due to disintegration of the ivory along the lines of growth.

IN the *Journal* of the Society of Arts for December 5, there s a paper by Mr. Alfred Watkins on some aspects of photographic development, setting forth the methods of work that have become associated with the author's name. A few observations recorded appear to be new, as, for example, that an increase of iodide in a rapid emulsion may increase the multiplying factor for development, and that a little iodide of potassium in the developer causes the image to appear almost as quickly at the back of the plate as at the front. The tendency appears to be to find new circumstances that interfere with the most usual course of events in development, and from the discussion that followed the paper we gather that at least some authorities still regard Mr. Watkins's generalisations as of rather too sweeping a character.

DR. G. HELLMANN has recently published the sixth of his useful discussions of the rainfall of the Prussian States, prepared at the request of the German Meteorological Office. The part now in question refers to the Provinces of Schleswig-Holstein and Hanover; the annual distribution of rainfall is clearly delineated, as before, on a coloured map showing the amounts for each 50 millimetres from 450 to 1400, and upwards, with an inset exhibiting the interesting values for the district of the Hartz Mountains. Particular attention is given to the greatest falls in one day, and shorter intervals, as being of considerable utility to engineers and others. The variations in the annual amounts at the same localities are, as usual, very considerable, and depend upon laws of which little is known at present, the rainfall of a wet year being occasionally double the amount of that in a dry year.

WE have received vol. xi. of *Deutsche überseeische meteorologische Beobachtungen*, published by the Deutsche Seewarte, containing the meteorological observations made in German East Africa, collected and discussed by Dr. H. Maurer. The observations were made at thirty-three stations; some of them date back as far as 1894, and some have been published in other places. Although the series is not complete and the observations are acknowledged to be not all of the same quality, they give, in the main features, a useful representation of the climate of a large district hitherto but little known. In bringing the data together in one volume, by very carefully collating them on the most approved plan and by giving full particulars of the stations and instruments, the Seewarte has rendered a great service to meteorological science.

MR. FREDERIC J. CHESHIRE describes, in the *Journal* of the Quekett Microscopical Club, a simple form of reflecting polariser. It consists of a single glass reflecting surface fixed at a constant angle of 33½° with the axis of the microscope in the position commonly occupied by the mirror, and capable of rotation about that axis without varying the inclination. The author points out the advantage of the increased field as compared with that obtained with a moderate sized Nicol's prism.

THE November issue of the *Journal* of the Franklin Institute contains an interesting paper on the conversion of amorphous carbon to graphite, by Mr. F. J. FitzGerald, chemist to the Acheson Graphite Company. The paper is largely historical, the experiments of Despretz, Berthelot, Moissan and others being described in some detail.

SHORTLY after the great Indian earthquake of June 12, 1897, a duplex pendulum seismograph was erected at Shillong, a town lying just within the epicentral area of the earthquake. The records of this instrument from August, 1897, to the end of 1901 have recently been examined by Mr. R. D. Oldham in order to ascertain if any traces of tidal influence were to be detected in the occurrence of shocks in what at that time was an extremely unstable portion of the earth's crust. Mr. Oldham arrives at the following conclusions, which, however, he regards as provisional and requiring verification from a more extended series of observations. There is, in the first place, a large variation in the diurnal distribution of earthquakes, maxima of frequency occurring between 10 and 11 p.m. and between 6 and 7 a.m. Superimposed on this large but unexplained variation in frequency, there is a smaller variation, which has the appearance of being due to the tidal stresses set up by the attraction of the sun. Also, if this smaller variation is really due to tidal stresses, then the horizontal stress is much more efficient than the vertical stress, and the effect is less due to the amount of the stress than to the rate and range of its variation.

A RECONNAISSANCE-SURVEY of Jebel Garra and the oasis of Kurkur, which lie to the west of Assuan and the first cataract on the Nile, has been made by Dr. John Ball (Survey Department, Public Works Ministry, Cairo, 1902). Jebel Garra (540 metres above sea-level) is a huge, flat-topped hill capped by Eocene limestone, which stands on the margin of the plateau and scarps of Upper Cretaceous strata bordering the Kurkur Oasis. These overlook the low, undulating country formed of Nubian sandstone which occupies the intervening desert, where much blown sand occurs. The Kurkur Oasis is formed by the confluence of several wadies or drainage-channels, which have no outlet, and it contains two wells. There is little hope of the oasis being able to maintain more than a few human beings, and at present there are no residents. The water occurs at an altitude of 330 metres, and it appears to be derived rather from local rain water, which drains through the Cretaceous white limestone, than from any more permanent underground supply.

AN analysis by Mr. Radcliffe Hall of the volcanic dust which fell at Barbadoes on October 16 agrees in a general way with Dr. Pollard's analysis of the dust of May 7 (see NATURE, June 5). The material analysed by Mr. Hall contained rather more alumina and alkalis than that analysed by Dr. Pollard, and less magnesia; facts which point to the conclusion that felspar and possibly also glass are more abundant in the October than in the May dust.

A joint commission appointed by the Royal Society and the London School of Tropical Medicine has been investigating the African sleeping sickness. This disease, endemic in the Congo basin, has recently been spreading eastwards with great rapidity, causing a terrible mortality. Of the commissioners, Dr. Christie and Dr. Low (Craggs research student of the London School of Tropical Medicine) are returning home, but Dr. Castellani is remaining to complete his investigations. The latter has isolated a streptococcus which seems to be the specific cause of the disease. The *rôle* of the *Filaria perstans* as the causative agent has been disproved by the commission.

A number of cases of serious anæmia having occurred in the Dolcoath mine, Cornwall, an inquiry was instituted by the Home Office into the cause of the affection. Dr. Haldane, with whom was afterwards associated Dr. Boycott, made the interesting discovery that the condition was one of ankylostomiasis, which is due to the presence of an intestinal parasite, the *Ankylostomum duodenale*. This disease is almost confined to tropical countries, though it was met with among the navvies employed in the piercing of the St. Gothard tunnel. Doubtless, in the present instance, some of the miners who had been working abroad contracted the disease and brought the infection home with them.

In the December number of the *Entomologist*, Mr. E. Bagwell-Purefoy gives further information with regard to the successful introduction of the brimstone butterfly into Tipperary, which was accomplished in 1894, after its feeding-plants had been planted a few years previously in the county. This butterfly —the *Gonepteryx rhamni* of some authors and the *Colias rhamni* of others—is found at Killarney and has been reported from Wicklow, but is not a native of any other part of Ireland. In 1896, the colony of Tipperary was found to be in a flourishing condition, and in 1901 and the present year had still further multiplied. During the past summer, Mr. Purefoy has attempted to introduce the handsome Mediterranean brimstone *G.* (or *C.*) *cleopatra* into the same district—an experiment which will be watched with interest.

In the September issue of the *Proceedings* of the Philadelphia Academy, Miss A. M. Fields records the results of experiments made with a view of ascertaining the cause of the hostility to one another displayed by different colonies of ants of the same species, and likewise the influence of light of different colours on these insects. The chief cause of the hostility of one colony to another appears to be a difference of odour accompanied by a difference in the age of the individuals composing the two colonies. As regards colours, it is inferred that ants are able to distinguish some of these, but may have no preference for one more than another. Also that these insects gradually lose their natural dislike of light by exposure to its influence.

The remarkable differences in the life-history of different colonies of an American land-planarian (*Planaria maculata*) form the subject of a paper by Mr. W. C. Curtis in a recent issue (vol. xxx. No. 7) of the *Proceedings* of the Boston (U.S.A.) Natural History Society. In certain localities, the creature apparently reproduces its kind exclusively by fission, while in others sexual reproduction occurs. There are yet other districts in which both modes take place. It is suggested that the asexual may replace the sexual mode of reproduction in the same individuals, but to confirm or disprove this, an extended period of observation is essential.

The third volume of Mr. W. S. Taggart's "Cotton Spinning" (Messrs. Macmillan and Co., Ltd.) has reached a second edition. The first two volumes deal with the preparing processes in cotton spinning, while this part takes up the subject of spinning and the preparation of yarns. Necessary additions have been made to the new edition so as to bring the book up to date.

In the Christmas number of *Photography*, Messrs. Iliffe and Sons, Ltd., have presented us with an excellent and inexpensive publication, printed on good paper and studded with numerous fine illustrations by various processes. This number has set itself the task of reviewing and displaying the most choice samples that have been shown to the public at the two great exhibitions held at the New and Dudley Galleries this year. A short but interesting monograph accompanies each illustration, drawing the reader's attention to the chief points. The publishers seem to have spared no pains to make the production, as a whole, high class in every respect, and the book will be found useful and valuable as illustrating types of subjects and treatments which are utilised and cultivated at the present time.

The additions to the Zoological Society's Gardens during the past week include a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. E. Bieber; a Banded Ichneumon (*Crossarchus fasiatus*) from Mozambique, presented by Mr. F. D. Samuel; a Raven (*Corvus corax*) British, presented by Mrs. Rose Haig Thomas; a Douglass's Horned Lizard (*Phrynosoma douglassi*) from the Rocky Mountains, presented by Mr. C. W. H. Doubler; a Hog Deer (*Cervus porcinus*) born in the Gardens.

Erratum.—In letter on p. 126, col. 2, l. 45, for "red out" read "red."

OUR ASTRONOMICAL COLUMN.

Comet 1902 *b* (Giacobini).—Further observations of this comet have been communicated to the *Astronomische Nachrichten* (No. 3833).

Mr. C. F. Pechule, of Copenhagen, made the following observation on December 3:—

14h. 38m. 20s. M.T. Copenhagen. $\Delta\alpha = -1$m. 22s.·00. $\Delta\delta = +1' \; 53''·7$. α (app.) = 7h. 17m. 26s.·56. δ (app.) $= -1° \; 51' \; 18''·0$, faint, 12th magnitude, small, diffuse.

New Variable Stars.—*Algol Variable*, 20, 1902, *Cygni.* —From photographs obtained by M. S. Blakjo, Madame Ceraski has found that the star having the position (1855) $\alpha = 21$h. 0m. 44s.·6, $\delta = +45° \; 11' \; 53''$, is a variable, and a further examination of ten plates indicates that it is a variable of the Algol type.

18, 1902, *Coronae.*—Mr. Thomas Anderson has observed that the star having the approximate position R.A. = 16h. 10m.·3, Dec. = + 38° 8', (1855), has been rapidly decreasing in brightness during November.

The following magnitudes have been observed:—November 1, 8·5; November 7, 8·7; November 18, 9·2; November 21, 9·3.

19, 1902, *Pegasi.*—Mr. Anderson also records the variability of the star having the position R.A. = 21h. 57m.·8, Dec. = +34° 25' (1855). At maximum, its magnitude is midway between 9·1 and 9·9, whilst at minimum it is only 0·2m. brighter than a neighbouring 11th-magnitude star. Its period is seven months (*Astronomische Nachrichten*, No. 3831).

Herschel's Nebulous Regions of the Heavens.—Dr. Isaac Roberts has recently completed his photographic survey of the fifty-two regions of the heavens described by William Herschel, in his paper "The Construction of the Heavens" (*Phil. Trans.*, 1811), as exhibiting extensive diffused nebulosity, and has communicated the results of this survey to the Royal Astronomical Society (*The Observatory*, No. 325).

Using a 20-inch reflector and a 5-inch Cooke lens to obtain simultaneous photographs, he has obtained negatives showing stars of magnitude 16–17 with the former, and of magnitude 14–15 with the latter instrument, thus securing images of objects at least as faint as those shown by Herschel's telescopes.

These photographs show that in forty-eight cases out of the fifty-two there is no trace of the extensive diffused nebulosity described by Herschel. On the remaining four, there is nebulosity which forms parts of three extensive nebulous clouds, which, however, Herschel could not have seen in so complete a form as they are shown on the photographs.

New Minor Planets.—Prof. Max Wolf announces, in No. 3831 of the *Astronomische Nachrichten*, the discovery of nine new minor planets. Three of these were found on a plate taken by Prof. Wolf on November 20, three others on a plate taken by Mr. Dugan on November 21, and the remaining three were found on a plate secured by Prof. Wolf on November 21.

ELEMENTS AND EPHEMERIS OF COMET 1902 *d*.—M. G. Fayet, of the Paris Observatory, has computed the following elements and ephemeris for the orbit of the new comet, from observations made on December 3, 5 and 8 :—

T = 1903 March 13·976 M.T. Paris.

$$\left.\begin{aligned} \pi &= 119^\circ\ 52'\ 40'' \\ \Omega &= 117\ 39\ 21 \\ i &= 43\ 53\ 9 \\ \log q &= 0{\cdot}45401 \end{aligned}\right\} 1902$$

Ephemeris 12h. M.T. Paris.

1902	α h. m. s.	δ ° ′	log Δ	Brightness.
Dec. 11	7 14 47	−0 39·1	0·3339	1·1
15	7 12 58	+0 4·5	0·3255	1·2
19	7 10 52	+0 52·8	0·3179	1·2
23	7 8 33	+1 45·8	0·3110	1·3
27	7 6 1	+2 43·3	0·3049	1·3
31	7 3 18	+3 45·1	0·2999	1·4

Brightness at time of discovery = 1.

An observation was made on December 10d. 13h. 37m. ·0 at Heidelberg by M. Courvoisier, and gave the following position for the comet :—108° 47′ 12″, − 0° 48′ 15″, and this gives a correction to Fayet's ephemeris of −2s. and +0′·6 (Kiel *Circular*, No. 55).

"COMPANION TO 'THE OBSERVATORY,' 1903."—This annual collection of elements and ephemerides, just published, contains its usual excellent list of tables and information in regard to the astronomical phenomena which will take place during the coming year.

The information concerning the various meteor showers and double stars is supplied by Messrs. Denning and Maw respectively, and M. Loewy has again contributed advance proofs from which the variable-star ephemerides have been compiled. The latter show a considerable increase in number this year.

JUPITER AND HIS GREAT RED SPOT.

THOUGH Jupiter has been unfavourably placed for European observers during the present year, his surface markings have been extremely interesting, of great variety and in plentiful numbers. The English climate, even at its best, can scarcely be said to suit astronomical work in an eminent degree, but its characteristics in 1902 have proved unusually bad, in fact, atmospheric conditions have combined with the low position of the planet to render observations difficult, and they have generally had to be pursued with definition of very inferior quality. The seeing has been recorded as "very good" on six nights only out of seventy-five, and in 1901 the result was equally disappointing, for the image was really sharp and satisfactory on five nights only out of seventy-one; but in 1901 the planet was about 5° lower (Dec. 23° S.) than in 1902 (Dec. 18° S.), and though the difference is not great, it ought to have operated strongly in favour of the present year had other circumstances been equal.

The most noteworthy incident in connection with recent studies of Jupiter is to be found in a very pronounced acceleration of motion in the great red spot. This first made itself evident in 1901, but it has been intensified during the past summer. For about twenty-three years, uninterruptedly, this singular marking had exhibited a constantly increasing retardation, which caused its rotation period to lengthen from about 9h. 55m. 34s. to nearly 9h. 55m. 42s. But in 1901 it declined to 9h. 55m. 41s., and during the present year the rate has been about 9h. 55m. 39½s. And this increase of velocity has been contemporary with the outbreak of a large, irregular or multiple marking of a dusky hue, in the same latitude of the planet. This new object, apparently first seen in May, 1901, has shown a rotation period of 9h. 55m. 18s., which corresponds with that of the south temperate current. It seems a probable conjecture that the presence of the marking just referred to may have forced the red spot along at a more rapid rate than that which it exhibited in previous years. In June, July and August of the present year, the red spot was almost surrounded by the material of the new marking, and the quicker motion of the latter may well have accelerated the movement of the former. But no certain conclusion can be arrived at, though the facts are significant and suggestive. Possibly the phenomena alluded to may have been practically coincident in date, but devoid of any physical relationship. And in this connection it will be useful to remember that the red spot has always been situated in a stream flowing along with much greater celerity than the rate of its own motion.

In September, the material of the new marking had passed to the preceding (W.) side of the red spot, and hence it was expected that the accelerated motion of the latter would cease, but the differences in motion have been comparatively slight, so that errors of observation make it unsafe to form definite conclusions. It will be advisable when the planet disappears from the evening sky in January next to collect all the transit times of the red spot recorded during the present apparition, as it may then be possible to determine with accuracy the extent of the acceleration and the variation in its rate, if any, during the summer and autumn. If a large number of observations are forthcoming, it will be desirable to group them into monthly or bi-monthly periods and ascertain the mean longitude of the spot for each of these, when the rate of its drift will be seen and the errors of individual transits practically obliterated.

At Bristol, the following estimated transits have been obtained with a 10-inch reflector and a power of 312 :—

Date. 1902.	G.M.T. h. m.	Longitude. °
April 28	16 14	45·9
May 20	14 23	44·7
June 20	14 56	44·8
,, 27	15 37	42·2
July 2	14 49	45·1
,, 7	13 54	43·9
,, 9	15 33	44·5
Aug. 8	10 8	40·2
,, 12	13 29	41·7
,, 15	10 57	42·5
,, 20	10 3	41·7
,, 25	9 7	39·6
Sept. 1	9 50	38·0
,, 13	9 48	40·3
,, 18	8 56½	40·5
,, 28	7 9	37·9
Oct. 3	6 18	37·9
,, 10	7 9	40·2
,, 15	6 13	37·1
,, 22	7 1	37·1
Nov. 8	6 8	36·9
,, 18	4 31½	39·4
,, 23	3 36	36·1
,, 25	5 20	39·1

During the present year, a number of white and dark spots have been visible on the north side of the north equatorial belt, and the mean rotation period of these has been about ten seconds less than that shown by the red spot. A new belt has lately formed on the northern side of the spots alluded to. The equatorial current of the planet has been moving, as nearly as possible, at the same rate as during 1901, for the mean rotation of twenty-four spots is about 9h. 50m. 29s. There has been an abundance of slow-moving N. and N.N. temperate markings, but these have seldom been well seen owing to the confused definition.

W. F. DENNING.

SOME LIMITS IN HEAVY ELECTRICAL ENGINEERING.[1]

IT is customary for a presidential address to be a review of the development of the science with which the Institution is particularly concerned. Such a review is especially beneficial in the case of such a rapidly growing industry as electrical engineering, as the outlook changes considerably during a year. Instead of a review of the past, a dream of the future may take the form of a presidential address. This form has great

1 Abridged from the inaugural address by the president of the Institution of Electrical Engineers, Mr. James Swinburne.

attractions for me for several reasons. In the first place, this kind of prophecy is easy and pleasant. I might draw a rosy picture of a future when everything conceivable is done electrically. We shall have electrical energy developed direct from carbon at the coal-pits. Not only all our lighting, but all our domestic heating will be done electrically. There will be no smoke in our cities or in what will correspond to them. Most of the dirt of our houses will have vanished. Large and crowded towns will have disappeared, because the telegraph will have given way to its wireless rival, and that will have given way to the wireless telephone with no exchanges and no subscriptions. There will thus be no need for people to go and see one another to transact business. Even when matters must be written to preserve a record, no office will be necessary. You will dictate by wireless telephony to your shorthand clerk at his distant house. Perhaps we shall all learn shorthand instead of our present cumbersome system of writing, and all books and letters will be in one language, written and printed phonetically at speaking speed or faster. The horse will have gone, leaving clean and odourless streets, with smooth surfaces on which people will travel in rapid electric automobiles. The railways with very rapid long-distance service will be entirely electric. It is very easy to prophesy in this sort of way, not only in a general way, but in considerable detail; and it is an amusement that brings much credit to the prophet. If any of his prophecies seem unlikely to come true, he merely has to say, "Wait a little!" While if anything like what he foretells comes into existence, say twenty years hence, all he has to do is to refer back to an address to claim that he has foretold it, and the future inventor will have half his credit taken from him and given to the prophet. If the prophecies are sufficiently vague, there is certain to be some sort of fulfilment of some of them sooner or later, and it is always well to have a good many past publications of this sort in stock waiting for future development.

Great though the temptation is, I will resist it, and try to look into the future from quite a different point of view. We have been going ahead so very fast lately—even our acceleration itself increasing—that we may be a little apt to have vague views of what we can and what we cannot do electrically. It may be well, therefore, to try to look over some of the branches of our great and diverse industry, and see what obstacles are now opposing us and what are likely to oppose us shortly, and whether the obstacles are insuperable or not. This sort of prophecy is much more difficult than the other, for there can be no credit twenty years hence in having said something could not be done, even if it has not, while if it has been accomplished the position is still more difficult. Negative prophecy is thus unattractive. But the discussion of our limits may not only have a beneficial effect in making us modest, but it may be a much greater benefit if, by focussing our attention on a limit of any development, we find either that the obstacle is theoretically insurmountable, in which case we must go round it, or that it has to be scaled in a particular way.

There are clearly at least two kinds of obstacles. For instance, it is obviously impossible to get more than 746 watts out of a dynamo taking one horse-power to drive it. But the limit of possible speed on an electric railway belongs to quite a different category. I will therefore discuss various branches of electrical technology, to see what may prevent or is preventing further advance.

Twenty years ago, this Institution was chiefly concerned with the development of the telegraph. We can get but few telegraph papers now. This is not because telegraphy is dead; it is because most of its problems are solved, so there is little to discuss. The fact that there is little to discuss in telegraphy is the proof of its vitality. It has passed out of the childhood of technical difficulties into the manhood of commercial development. Ten years ago, we were in the thick of the evolution of the dynamo and the transformer. Now there is little but detail to discuss about electrical generating machinery. This is because heavy electrical machinery has got through its difficult infancy and is now a trade, which is the highest compliment that can be paid to it. But we electrical engineers have also developed through our difficult training into being the scientific branch of the engineering profession. Our exactness of calculation and measurement has leavened the steam engineers and the other manufacturers with whom we have to work in concert.

No one man can be a complete electrical engineer; but each of us ought to know one subject well and a large number of allied subjects fairly well. As a basis of technical knowledge, which I am alone dealing with to-night, we must have a fairly all-round knowledge of "theoretical" physics and chemistry. Physics is merely unapplied engineering. Science is split—unfortunately, the split is very difficult to heal—into two parts, generally wrongly called the theory and the practice; or pure and applied science. This fissure is not so deep in our branch of engineering, but it is there. Science, to be worthy of the name, is knowledge of Nature utilised by man. Engineering is science, and science is engineering. You can cut off a part and call it unapplied science. This is what is generally known as theory or pure science. It is not purer than any other science, and the term theory is misapplied. To be an engineer you must know both branches. There is nothing superior about knowledge which is not yet applied. It is mere raw material; it may be useful when worked up, and it is valuable before it is worked up, but only because it may be worked up. The so-called practical man who works at applications without understanding the generalised principles is ignorant. He only understands a part of science. The so-called scientific man who only understands what is called pure science is just as ignorant. Each understands part of his subject only.

We as electrical engineers ought especially to heal the split between the halves of science; a split which is much deeper in other branches of engineering, such as chemical and purely mechanical. We ought to unite knowledge of both branches of science in one individual as much as possible.

Tides.

The tides are often referred to as a possible source of energy even to this day; and it is urged that in places where the tide rises abnormally, for instance in the estuary of the Severn, it would pay to make a dam with turbines. The sort of argument is that if you have an area of, say, 1000 square metres and a total rise of 15 metres, you have 15,000 cubic metres of water, and as this runs in twice and out twice a day, you have 15,000 cubic metres of water, falling the equivalent of 60 metres a day, or approximately 100 kilowatts. This statement contains many fallacies. In the first place, in order to get the full advantage of the difference of level, the water must be let in and out at high and low tide only. Even then the equivalent or average head during discharge or charge is only $7\frac{1}{2}$ metres. But a system which gave an enormous power for a very short time four times a day would be of no use. The plant would be expensive and the result of no value. With a single tank it is impossible to get a continuous output. If the tide is coming in and you get power by letting the tide fill the tank, the power will decrease to zero as the tide begins to fall and comes to the same level as the water in the tank. It is therefore necessary to have more than one tank. To make the plant practical, you want fairly constant pressure available on the turbines, though you may waste head by sluices or valves. It is often said that a Norwegian fiord or a Scotch loch could be easily dammed and utilised, but it would be impossible to find three lochs all opening out together. The need for more than one reservoir does not seem to have been recognised. In addition, the demand for electrical energy on Scotch lochs or Norwegian fiords is rather minute.

Water Power.

Some years ago, there was a great deal of excitement about the development of water powers. The possibility of "harnessing Niagara" and utilising waterfalls all over the world was hailed as a great triumph over Nature, and the idea was that power could be got for nothing, and industries would all migrate from coal districts to the neighbourhood of water powers. The daily Press and the magazines took the matter up, and there is something in the idea of saving some of the colossal waste of natural energy that appealed especially to the half-scientific or unpractical reader. At the time of the excitement, it was pointed out, largely in vain, that water power did not cost nothing, because the development of a fall demanded a good deal of capital, on which interest and depreciation had to be paid. But further than this, Ricardo's theory of rent is applicable to water powers as well as to arable land. If steam power costs a farthing a unit, and if water power at the same place can be produced for half a farthing, after paying working expenses and interest, the owner of the water power will claim the odd half farthing as rent, or will just allow the water power enough to encourage the production of a new thing. As a rule, however, a water power is not where it is wanted industrially. In the nature of things, water powers are generally in hilly countries, and are seldom near the sea. The result is that a water power as a rule cannot command the same price as steam or gas, because it is not where it is wanted. The idea in starting many of the water-power stations also was that works which needed power would come and settle near. As a matter of fact, the cost of power is a much smaller item in most industries than is generally supposed, and it does not pay to start a works in an otherwise not perfectly suitable locality simply for the sake of the cheap water power. In such industries as engine building, flour milling, spinning and weaving, and so on, the chance of reducing the expense for power is not enough to overcome other considerations. It may be said that in electro-metallurgical processes the whole cost is practically the electrical energy, and so carbides, aluminium, electrolytic soda and chlorate of potash will be made at water powers. Even this, however, is misleading. Carbides and aluminium are generally made at waterfalls, and chlorate nearly always is. Electrolytic soda and bleach are made at water powers, but are also made extensively by steam-driven plant. Against the cheaper power, we have to put extra carriage for materials and for coal, which is often needed in addition, and extra carriage for finished products, and very often extra cost of labour, as labour is often dear and bad in water-power districts. It may thus easily pay to use much more expensive power if the other conditions are more favourable. Steam power, for instance, will cost three or three-and-a-half times as much, and yet it pays to make electrolytic caustic and bleach in England where the other conditions are all favourable. It is not, therefore, the want of water power that has kept the electrolytic industry back in this country. For a water power to be really valuable, it should be near a source of material, on the sea, and should have a great head of water, so that the capital cost of development is small. Such a water power is very valuable—to the landlord.

A blast furnace is more valuable than a water power. There are plenty in England. But the owners, who have been wasting the gas up to now, will not give it away; they will want rent, so that it will only just pay to use this gas rather than make it. The electrical industry thus does not gain, but the ironmasters do.

Carbon Cells.

For many years, "electrical energy direct from coal" has been the dream of the electro-chemist. That is to say, he has dreamed of an electrolytic cell in which the consumed electrode is carbon. The best way to realise the difficulties of this problem is to consider it solved and see what it means. The carbon must be in contact with an electrolyte, and that electrolyte must either be in contact with a second electrolyte which wets the other electrode or must itself be in contact with that electrode. This second electrode must almost certainly be metal, as there are no other non-metallic conductors available. Such compounds as the hydrides, nitride, oxides, chloride, bromide, or the sulphide, or silicide, of carbon are not salts in the electrolytic sense. Carbon forms part of the electro-positive radicle in the organic radicles and part of the electro-negative radicle in the cyanogen compounds, but it is never a radicle by itself. To sum up the matter shortly in the light of modern theory, carbon never forms ions, and has therefore no solution pressure, and can therefore give no electromotive force. At ordinary or moderate temperatures, carbon is practically inert. Oxidising agents will attack some forms slightly, and sulphuric acid will attack it. In this latter case, the formation of water and its combination with the acid is the determining factor. At high temperatures, oxygen, sulphur, silicon, and to some extent nitrogen, and many of the metals combine with carbon, but there is no dissociable salt of carbon formed. The carbon cell thus seems impossible. Such schemes as Mr. Reed's, ingenious as it is, is not a solution of the problem. It would be simpler to reduce zinc oxide with the carbon and then put it in a zinc cell.

It is hardly necessary to discuss thermopiles or thermomagnetic engines as possible economical producers of electric power.

Steam Engines.

The primary question in all heat motors is, What temperature range is available? In the case of a steam engine, there is enormous waste of mutivity—to use a variation of Lord Kelvin's convenient term—in boiler flues. We burn carbon and hydrogen, capable even with air of giving a temperature of some 1500° C., and the heat is degraded down to some 200° C. That is to say, instead of getting the heat with a mutivity of about 0·825, we degrade it down to, say, 0·35, a clear loss of 0·45 out of 0·8, or 56 per cent. This degradation is apart from the efficiency; the efficiency is concerned with the loss of heat up the chimney. The higher limit in large modern reciprocating engines may be taken, roughly, at 600° A. (327° C. or 620° F). Above this, there is difficulty in lubrication and to some extent weakening of the material. The pressure corresponding to this temperature for saturated steam is out of the question, and the pressure may be taken at, say, 12·5 megadynes per square centimetre or 12½ atmospheres, or 200 lb. per square inch, and steam leaving the boiler superheated to 600° A. does not get at the cylinder lubrication at that temperature. Our limits in the steam engine are thus pretty clearly defined. The pressure is the essential factor. Superheating is not much good in the way of getting higher mutivity in the boiler, nor is it very important in getting much more energy into the steam.

The turbine is under the same limit as regards pressure; in fact, high pressures are perhaps even more difficult to use, and superheating does not, as already explained, seriously increase the mutivity of the heat taken in by the boiler.

One of the chief disadvantages of steam engines for stations with small load-factors is the difficulty of storing energy so as to get uniform boiler load. Batteries are no longer used for this, and the difficulty reduces the value of steam in comparison with the gas engine. Mr. Druitt Halpin has proposed, and used, "thermal storage." Lagged vessels are filled with water raised to the temperature of the working steam. This arrangement, however, is not isothermic; that is to say, to get out the energy the temperature must fall. What is wanted is a reservoir containing something which undergoes a physical or chemical isothermal change. For instance, a substance that fuses at the right temperature and has a high latent heat of fusion, or a substance which, like sulphur, changes allotropically with considerable change of internal energy, at a suitable temperature. Unfortunately, there is no substance within the range of practical engineering. Moreover, the storage is on the wrong side of the engine. To store heat with a mutivity of only some 0·35 is not so promising as to store some higher form of energy. The secondary battery thus begins with an apparent advantage. The difficulty of storage is another drawback to the steam engine, and gives the gas engine a further advantage.

The Gas Engine.

There is no other comprehensive name that covers the type of engine worked by gas and oil. The combustion need not be internal, and perhaps will not be internal in the future, but in a sense all are worked by gases.

We have in the gas engine a machine which, from a thermodynamical point of view, ought to be exceedingly good; but the difficulties in building, especially very large engines to utilise the high possible mutivity and saving by having the heat produced where used, reduce the efficiency of the gas engine enormously. In spite of that, the large gas engine seems likely to oust the steam engine for large powers during the next few years. The best way to get a high efficiency out of a gas engine would probably be to make it compound, exhausting at a temperature suitable for raising steam. The steam engine would then exhaust at a temperature suitable for raising SO_2 vapour. But the chances are that Dowson, Mond or other producer gas will be available at such low prices that the extra steam and dioxide engines would not pay for attendance, interest and depreciation. With very cheap gas, the first thing is to make big engines, the next to make them so that they never break down, and the last thing to make them efficient. The gas engine may be, comparatively speaking, in the state Watt left the steam engine, but it will doubtless make very rapid advances, as it is in the hands of very competent and highly educated engineers.

Dynamos.

As regards efficiency, we have reached the practical limit already, for further reduction in dynamo losses would make no appreciable difference in the total efficiency of a station. In fact, we are rather following continental practice in having slow-running machines with many poles, even for direct currents, and efficiencies are perhaps lower for large machines than in the best English practice of a few years ago. This is also true as regards output from a given size. We are not likely to make much advance in dynamos now, as we are limited on one hand by the hysteresis loss in iron, which prevents our using higher inductions in armatures, and low permeability, which limits our field and armature tooth inductions. It does not seem likely that we shall now find iron much better in either respect. Nor are we likely to find a better available conductor than pure copper. As insulator we have mica. It looks, therefore, as if we were within sight of our limits in dynamo and motor designs.

Secondary Batteries.

The secondary battery in central station work has been used as a store to equalise the load, and to reduce the running plant at the times of heavy load. Owing to the high full-load station pressure with feeder systems, the station battery is generally for use at light loads only. But the secondary battery has for a long time been on the border of success for traction work, both on tramways and on the road, and a further improvement in batteries may be expected to produce very great changes in important branches of engineering.

The first question asked is, Why do we stick to lead? The answer is that the case is very special and other things will not do. We are practically limited to lead, at any rate in acid cells. Take first the plate that oxidises on discharge. It should not dissolve in the electrolyte, as if it does the deposition and solution will be uneven, and the plate will grow trees and come to grief. This puts zinc out of court, unless some electrolyte is used which gives some insoluble salt of zinc, which does not attack zinc on open circuit, and gives a good electromotive force with it. Iron is out of court for the same reason; there is no suitable electrolyte. The strong organic acids such as trichloracetic or oxalic are apt to have their positive radicles split up by electrolysis, even if a strongly positive metal can be found with an insoluble salt. Lead is thus the only metal practically available in an acid electrolyte. Silver in hydrochloric acid would give no pressure, and the acid would be decomposed at the anode. On the other plate we need an insoluble depolariser, else a two-fluid cell must be used, involving a porous diaphragm, diffusion and impracticability. Not only must the depolariser be insoluble, but it must be converted into an insoluble body on discharge. The coating must be a conductor in one state or the other, or there will be no proper contact. In the lead cell, there is always enough peroxide and metallic lead in the coatings to secure electrical contact though the discharge product is an insulator. The depolarising coating must be connected to a conducting plate which is not attacked by local action. Lead and silver are the only available metals, and sulphuric, and perhaps phosphoric, the only acids, for the nitrate of lead is soluble and hydrochloric acid is decomposed by lead peroxide. Lead is protected by its coating of sulphate, or peroxide as the case may be. It thus seems as if we were limited almost absolutely to lead and sulphuric acid. It is wonderful that we have the lead cell at all. We owe it to the chance observation of Planté. The theory was not understood for a long time. For many years it was thought that the pressure was due to the PbO_2 and Pb changing into PbO. The acid was merely put in to make the electrolyte conduct, and sulphuric acid was used because people used it in gas voltameters, and they never thought that it ought to be as strong as practicable to give the pressure and output. The formation of lead sulphate was regarded as a difficulty to be overcome.

In the lead cell we want lightness, large capacity, cheapness, rapid discharge, efficiency and mechanical strength, and durability. These qualities are mostly antagonistic. Large capacity means rapid deterioration. Mechanical strength means weight. It is thus no use testing a cell for capacity without testing the efficiency and durability too, and so on. Published battery reports are often misleading, because they omit essential information.

Cables.

The conductor itself can hardly be improved, but there is great room for improvement in the insulation. It is largely the insulation of the cables that limits our pressures, and therefore our distances of transmission. For 1000 kilowatt cables, the cost is about a minimum for 8000 volts; above that, the cost of insulation increases faster than the cost of copper falls. It is exceedingly unlikely we have reached the limit in insulation. There is no branch of electrical engineering so important as cable making. Cables form a large portion of the capital outlay in large systems. Yet there is no branch of the industry which is run on less scientific lines. The days of secret mixtures known only to the workman who makes them may be passing away; but even now the whole art of cable-making is a question of trial and error, with a good deal of the last component. Engineers do not know now whether rubber is better than paper, nor can they tell what any particular make of cable will be like after ten years' use.

Light.

Our chief work, until lately, has been producing light. Here the inefficiency and waste is prodigious, and though it is mostly unavoidable, there is still great room for improvement. We take great care over our stations, watching every penny from the coal shovel or mechanical stoker to the station meter. We quarrel over 1 per cent. in the generators. When we get to the mains we care less, and once we have got to the consumers' meters we care nothing at all.

Practically all light is wanted for use by the human eye. The human eye is exceedingly sensitive; it is calculated to see a distant star when receiving 10^{-8} ergs per second, so that one watt would enable, say, five thousand billion people to see stars with both eyes, but it would have to be used economically. In reading a book, the eye would need much more than this; and then, as the book radiates light in half of all directions, only a little is used by the eye, so even if all the light from a source were concentrated on a book, there is enormous waste by useless radiation from the book. But the source of light does not illuminate only the book; the book probably subtends a small solid angle, so we have another source of waste. The eyes reading a book in a fairly good light want something of the order of two ergs per second, so that a watt would only work the optic nerves of, say, the inhabitants of London. But the book, say 200 square centimetres, would need about 3000 ergs a second to illuminate it. A candle, which gives a light of 4π, radiates about 0·2 watt, or five candles a watt; that is to say, at an efficiency of unity, we would get five candle-power or 20 units of light per watt. The efficiency of a glow-lamp is only about 0·25 candle-power per watt, or 0·05, so there is room for improvement. The first thing, naturally, is to see what limits there are in the way of increased efficiency. The obvious goal is direct production of "light without heat," by which is meant producing only the rays of wave-lengths which affect the eye.

There is no thermodynamical reason why electrical energy should not be converted directly into radiation of any wave-length without loss; I do not know if there is any molecular impossibility, but apparently our limits are practical—that is to say, it may be done, but we have not yet hit on the way of doing it. The vacuum tube appears to be a means of converting electric power direct into radiation. The Cooper-Hewitt lamp, for instance, gives an efficiency of about three candles per watt, or something like 0·6. All these figures as to light are a little vague. Unfortunately, the light is of a very bad colour. It is very actinic, but the wave-lengths are too small. One method is to degrade the light by making it act on silk dyed with matters which lower the radiation to a redder colour by fluorescence.

The Arc Light.

The arc has been very fully studied in some directions and not in others. Most makers of arc lamps seem to devote their whole attention to the mechanism, and look upon the arc merely as a hot gap that has to be preserved by suitable apparatus. Many lamp makers, on the other hand, have records of exhaustive experiments on the relations of the pressure, current and light with different carbons; but they are very seldom published. On the other hand, an enormous amount of laborious experiment on such points as these is available, and on the back electromotive force of the arc. The physics of the arc, an exceedingly difficult branch of study, has not received much systematic attention yet. The crater of an arc is, no doubt, heated to the point of volatilisation of carbon at the pressure of the air. If other gases get at the crater, the vaporisation temperature would be less. (There is a small increase of pressure which I suggest is due to the electromagnetic effect of a current localised in a conducting fluid. This may be neglected.) The crater may be rough, as carbon, though it softens, does not melt before volatilising, and it may be merely speckled with points at its volatilising temperature, so that its brightness is not uniform. But there are so many anomalies about the arc that one cannot say anything definite with safety. For instance, if the temperature is limited by the vaporisation of carbon, what must be the specific heat of vaporisation of carbon? Where does the vapour go, and what happens to it in an enclosed lamp? In condensing into smoke, it should give light of the same colour as the crater. If it has an enormous specific heat, it ought to raise the other pole to crater temperature where it condenses. If it is a light gas, a large portion of its specific heat of vaporisation may go to external work. Most of the upper carbon is burnt away by external air; if a pencil to match the crater is volatilised, it does not account for much power. If the vapour is very light, there must be large volumes from the upper carbon. Then what conducts? Carbon vapour alone, or mixed with a little monoxide or nitrogen, is a very good conductor at these temperatures. Does that go to show that carbon vapour dissociates like iodine or chlorine, &c.? The whole question of the physics of the arc deserves far more careful study than it has yet received, but the work is surrounded with difficulties and is really a branch of the theory of the passage of electricity through gases, a matter of the greatest scientific importance, somewhat out of our way as practical electrical engineers. But as engineers in the broader sense, we are as much interested in questions of recondite physics as of costs of generation.

To sum up as to the arc light, we do not seem to have reached our limit as to light from pure heating, because we lose a lot of light into the opposite carbon. Many attempts have been made to expose the crater freely. But, far more important than this, I would urge that the arc is not necessarily a hot body radiator only, but that it may also convert electrical power directly into light in the space between the electrodes, and this gives a chance of rising more nearly to our theoretical limit of about five candles per watt.

The Incandescent Lamp.

This simple hot carbon wire in a bulb involves the most extraordinary physical complexities. A great many curious things go on inside the simple-looking globe. A good account of what is known—especially since he took the subject in hand—has been written by Dr. Fleming, and the scientific manufacture of this interesting article has been fully described by Mr. Ram. The incandescent lamp is a simple hot body radiator, and the limit of efficiency depends chiefly on the temperature of the carbon. As we are limited by the size of mains, we can only use pressures of 100 volts or 200 volts, and this limits us to carbon or something of still higher specific resistance. The sensitiveness of the carbon lamp to pressure in its turn limits the practical variation of pressure of supply, and thus costs us very heavily in mains. If we had incandescent lamps which did not mind 20 per cent. pressure variation, we would have saved millions in mains in this country alone.

The idea of making lamps of carbides has become very fashionable lately. People have put oxides into carbon for the last twenty years. The old idea is to get hold of an oxide that radiates more light at a given temperature than it ought to, which is itself a fallacy, while the idea of oxide in contact with carbon is chemically absurd. There is no oxide irreducible by hot carbon. The carbides are not by any means all refractory. Some are, though, but there are immense difficulties in making carbide lamps. To make a fine filament material of an infusible material, which can be made only at electric furnace temperatures and is generally decomposed by moist air, is not an easy task. It is easy to think you have made a carbide lamp by incorporating an oxide in the filament material, but the resulting filament is generally mostly, if not wholly, carbon. What happens to the metal in the circumstances is rather a mystery. There is, however, a chance of enlarging our limits in incandescent lamps of the ordinary kind, but it seems strange that the melting points of all known materials should suddenly reach a higher limit. Assuming the Stefan-Boltzmann law for ordinary light radiations, the fact that the efficiencies of refractory bodies all reach limits of the same order shows that the most refractory bodies melt at about the same temperature, somewhere in the neighbourhood of 3000° A. Whatever the inter-molecular forces may be that bind the particles to make solids, the vibration forces due to temperature seem to overcome the greatest at about 3000°.

Instead of an ordinary conductor, Nernst uses an electrolyte which stands a higher temperature. The conduction is electrolytic, as can easily be shown, but there are many curious phenomena, many of them so far unexplained, in the Nernst lamp. The efficiency of the Nernst lamp is about 0·6 candle per watt. It was at one time supposed to owe its efficiency to selective emission, but there is no reason to doubt that it is a pure temperature radiation.

Electric Heating.

The limit of electric heating is clearly purely financial. To convert heat into other energy with a very small efficiency and to send it out by expensive cables and then to degrade the energy down to heat again is obviously much dearer than burning coal or gas direct. But in many domestic cases, the convenience is so great that the limit is not so low as might be thought, and electric heating for cooking and other domestic uses may develop considerably. The electric arc and incandescent lamps are essentially cases of electric heating. By far the most important use of electric heating is the furnace. Here the temperature available is only limited by the volatilisation of the electrodes, and this enables us to get temperatures otherwise unavailable, so that we can get chemical actions which are impossible at lower temperatures, either because they are endothermic or because the materials do not come into chemical contact at ordinary temperatures. It is impossible to say what our limits are in the electrical furnace. Probably the temperature is limited by the volatilising of carbon. The products are not limited to endothermic compounds; the furnace is useful for the reduction of metals and phosphorus, and for melting glass and, it is hoped, silica for optical and laboratory purposes, and perhaps for cooking utensils and evaporating pans and crucibles in chemical engineering and metallurgy.

Railways.

It is almost absurd to begin to consider the limits of the use of electrical transmission on railways at this date. The future of electric railways, electric tramways and automobiles is rather a matter of vague conjecture and picturesque prophecy. Tubes are multiplying rapidly, and railways are putting down electric transmission on suburban lines in Europe and the States. On short lines with many stops, we have to contend with inefficiency at starting. On long lines, there is difficulty of transmission or cost of transformation and difficulties of collection. We are limited by the want of either a variable speed simple alternate-current motor or a simple variable speed-gear capable of transmitting a very large torque and packing into an engine. A recently developed scheme is the use of low-frequency alternating currents with laminated series-wound motors. This solves the difficulty, but at the expense of large idle current, induced pressure in short-circuited armature coils, large expensive and inefficient transformers, and the ordinary disadvantages of the series-motor on constant pressure. This plan is well worth serious study.

The collection of large currents at great speeds has long loomed as a limit. The published accounts of experiments at Zossen would lead us to suppose there is no trouble on this score. Still, it is a difficulty many engineers fear.

In electric tramways, there is no limit in sight. The power can be sent over any distance desired, and there seems to be no limit to the people who want to travel on electrical trams. The question of electrolysis is rather that of a limit to the duration of pipe companies' property. It is a very difficult question. Though the threatened effects of electrolysis have no doubt been exaggerated, it is at best a question of degree, and the ingenuity of engineers is continually reducing the chance of damage. It has recently been urged that frequent reversals of polarity of the system reduce the electrolysis very considerably.

Electrolysis.

This is a branch of industry in which it is very difficult to tell our limits. In electrolytic copper-refining, our limit is that of the copper wanted. Our electrolytic industries suffer mostly from the limits of intelligence of the investing public. It is assumed that we cannot do electrolysis in England because we have no water power. This is only an excuse for inactivity. As already explained, we can do just as well without water power. A blast furnace is much more valuable than a waterfall of similar power, because it is near coal and in an industrial district. Moreover, as already explained, the cost of electrical energy is a small portion of that of most electrolytic products. At first, electrolysis was to be applied to copper-refining. Then to caustic soda. The output of electrolytic caustic is really rather limited by the demand for bleach. What is urgently wanted is some other way of storing and carrying chlorine. Steel bottles and compression plant are an unsatisfactory solution. What are the limits in the way of electrolysing fused salt They are all incidental limits. The containing vessel is difficulty. Sodium vapour attacks all silicates. Sodium distils near the temperature of fused salt. If not volatilised, it forms a conducting bridge from the kathode. It attacks iron, though slowly. Hot porcelain and earthenware conduct electrolytically—as, by the way, the maker of electric frying-pans knows—hot chlorine attacks metals, even when dry, and hot carbon cannot be exposed to the air. In addition, sodium and perhaps chlorine are soluble in hot salt, and traces of sulphate in the salt act as carriers. I could a tale unfold if I read out laboratory notes of sodium experiments on a fairly large scale. The difficulties are all incidental, though, and I have little doubt electrolytic sodium at a few pounds per ton will be in the market soon, and will affect profoundly many chemical and metallurgical industries.

In metallurgy, electrolytic solution processes are in use or on trial for the more valuable metals, such as copper and nickel. The reaction between chlorine and metallic sulphides at high temperatures brings the whole domain of sulphide ores under our sway. Thus a sulphide, say galena, is treated with chlorine, which gives off the sulphur as sulphur, which is condensed and sold, making chloride of lead. The silver is extracted by stirring with a little lead, and the fused salt is then electrolysed, yielding pure desilverised lead and chlorine. The process is thus self-contained, yielding sulphur, lead and silver. It is specially applicable to mixed refractory ores which are now nearly valueless and very plentiful, and contain much metal content, such as the mixed lead-zinc sulphides of America or Australia. These reactions have been proved on the large or ton scale, and there is no technical difficulty. Unfortunately, mine people are somewhat ignorant of electrical matters, and it is exceedingly difficult to get them to understand or appreciate a process like this, capable though it may be of paying good dividends on very large capitals indeed.

Our limit in electrolysis in this country is almost entirely human inertia. Commercial and financial people do not understand it, and fight shy of it. But our technical people are nearly as bad. The pure physicist, as a rule, takes no interest in electrolysis or physical chemistry, and thinks it belongs to the chemical classroom on the other side of the passage. The chemist thinks it is higher mathematics and will have none of it, the mathematician thinks it may be an exercise in differential equations; but they are all agreed that it is a sort of continental fungus which flourishes with no roots, and that it is beneath the attention of a scientific man to know enough about it to give a reason for the broad statement that it is all nonsense.

DUTY-FREE ALCOHOL FOR SCIENTIFIC PURPOSES.

TEACHERS of organic chemistry have often expressed the opinion that alcohol used for purposes of education and research should be relieved of the heavy duty levied upon it. Two years ago, attention was directed to the need for action in the matter, and at the Glasgow meeting of the British Association in 1901, a committee was appointed, with instructions to approach the Board of Inland Revenue, with the object of endeavouring to secure the removal of this tax upon scientific work. As the result, the following regulations have been issued by the Board and published in the daily Press:—

Regulations for the Use of Duty-free Spirit at Universities, Colleges, &c.

(1) An application must be made by the governing body or their representatives, stating the situation of the particular university, college, or public institution for research or teaching, the number of the laboratories therein, the purpose or purposes to which the spirits are to be applied, the bulk qnantity likely to be required in the course of a year, and, if it amounts to fifty gallons or upwards, the name or names of one or more sureties, or a guarantee society to join in a bond that the spirits will be used solely for the purpose requested and at the place specified.

(2) The spirits received at any one institution must only be used in the laboratories of that institution, and must not be distributed for use in the laboratories of any other institution, or used for any other purpose than those authorised.

(3) Only plain British spirits or unsweetened foreign spirits of not less strength than 50 degrees over proof (*i.e.* containing not less than 80 per cent. by weight of absolute alcohol) may be received duty free, and the differential duty must be paid on the foreign spirits.

(4) The spirits must be received under bond either from a distillery or from an Excise or Customs general warehouse and (except with special permission) in quantities of not less than nine bulk gallons at a time. They will be obtainable only on presentation of a requisition signed by the proper supervisor.

(5) On the arrival of the spirits at the institution, the proper Revenue officer should be informed, and the vessels, casks or packages containing them are not to be opened until he has taken an account of the spirits.

(6) The stock of spirits in each institution must be kept under lock in a special compartment under the control of a professor or some responsible officer of the university, college or institution.

(7) The spirits received by the responsible officer of the institution may be distributed by him undiluted to any of the laboratories on the same premises.

(8) No distribution of spirits may be made from the receiving laboratory to other laboratories which are not within the same premises.

(9) A stock book must be provided and kept at the receiving laboratory in which is to be entered on the debit side an account of the bulk and proof gallons of spirits received with the date of receipt, and on the credit side an account of the bulk and proof gallons distributed to other laboratories. A stock book must also be kept at each other laboratory, in which must be entered on the day of receipt an account of the bulk and proof gallons of spirits received from the receiving laboratory.

These books must be open at all times to the inspection of the Revenue officer, and he will be at liberty to make any extract from them which he may consider necessary.

(10) The quantity of spirits in stock at any one time must not exceed half the estimated quantity required in a year where that quantity amounts to twenty gallons or upwards.

(11) Any contravention of the regulations may involve the withdrawal of the Board's authority to use duty-free spirits.

(12) It must be understood that the Board of Inland Revenue reserve to themselves full discretion to withhold permission for the use of duty-free spirit in any case in which the circumstances may not seem to them to be such as to warrant the grant of it.

J. B. MEERS,
Secretary.

Inland Revenue, Somerset House, W.C., November 17.

NOTE.—"Proof Spirit" is defined by law to be such spirit as at the temperature of 51° Fahrenheit shall weigh $\frac{12}{13}$ths of an equal measure of distilled water.

Taking water at 51° Fahrenheit as unity, the specific gravity of "proof spirit" at 51° Fahrenheit is 0·92308. When such spirit is raised to the more usual temperature of 60° Fahrenheit, the specific gravity is 0·91984.

To calculate the quantity of spirits at proof in a given quantity of spirit over or under proof strength:—Multiply the quantity of spirit by the number of degrees of strength of the spirit, and divide the product by 100. The number of degrees of strength of any spirit is 100 *plus* the number of degrees overproof, or *minus* the number of degrees underproof.

EXAMPLE:—19·8 gallons of spirits at 64·5 overproof
100 + 64·5 = 164·5 proof strength.
164·5 × 19·8 ÷ 100 = 32·571
taken as 32·5 gallons at proof.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In connection with the School of Geography, Mr. Mackinder will lecture weekly during Hilary term on the historical geography of Europe, Mr. Dickson will lecture on surveying and mapping and on the climatic regions of the globe; he will also give, in conjunction with Mr. Darbishire, practical instruction in military topography; Mr. Herbertson will lecture on the British Isles, the regional geography of continental Europe, and on types of land forms, mountains and coasts; Dr. Grundy will lecture on the historical topography of Greece, and Mr. Beazley on the period of the great discoveries, 1480-1650.

SIR WILLIAM COLLINS has accepted the invitation to stand as the Liberal candidate for London University at the ensuing Parliamentary by-election.

WE learn from *Science* that at a recent meeting of the National Academy of Sciences, a grant of eight hundred dollars was made from the income of the J. Lawrence Smith bequest to Dr. O. C. Farrington, of the Field Columbian Museum, Chicago, to enable him to conduct certain investigations upon American meteorites.

JUST as in this country there are gratifying signs that teachers in secondary schools are making earnest efforts to acquaint themselves with scientific methods of teaching the subjects of the school curriculum, so in France there is a movement in the same direction. We learn from the *Révue générale des Sciences* that M. Liard, vice-rector of the Académie de Paris, is organising conferences of teachers in secondary schools at which the chief inspectors will explain to French schoolmasters the objects it is desired they shall have in view in their teaching. The first conference was confined to teachers of modern languages and the second was devoted to a consideration of the teaching of physical and natural science.

ANOTHER instance of the large scale on which provision is made for every grade of education in America is afforded by the post-graduate medical school that has recently been incorporated in the city of Washington. There are to be, we learn from the *Lancet*, 104 professorships established, as follows:—Six of preventive medicine, two of medical zoology, one of protective inoculation, serum-therapy and biochemistry, two of sanitary chemistry, eight of bacteriology, seven of pathology, fourteen of internal medicine and therapeutics, one of surgical anatomy, fourteen of surgery, six of military medicine and surgery, two of orthopædic surgery, nine of gynæcology, six of obstetrics, three of tropical diseases, four of diseases of children, two of mental and nervous diseases and electrotherapeutics, two of diseases of the stomach, eight of diseases of the eye, eight of diseases of the nose, throat and ear, four of special diseases and four of diseases of the skin.

THE examination of the calendars of different University Colleges soon convinces the student of education that every class of society in the city where the college is located must come under its influence. In the case of the University College of Nottingham, for example, we find from the new calendar that for the twenty-second session of the college there are, in addition to lectures for preparing to graduate in the various university faculties, classes for artisans engaged in the engineering, building, and lace and hosiery trades. Students of the same college may be studying subjects so far removed as Greek and plumbing, Anglo-Saxon and pattern-making. While one student is training to become a schoolmaster and is attending lectures on psychology and pedagogics, another hopes to develop into an electrical engineer, and spends his time at electrical measurements in the physical laboratory. In such an institution, it should be impossible for a student to obtain other than a broad, catholic way of regarding the various branches of human knowledge.

IT is a pertinent question whether we as a nation are incapable of looking ahead or whether we are too apathetic to provide for future contingencies. On all sides, warning voices proclaim the deficiencies in our educational system, lack of enterprise and antiquated methods. Prof. Bower availed himself of the opportunity afforded when he was delivering his inaugural address before the North British branch of the Pharmaceutical Society to point out how one practical side of botany, the study of vegetable economics, is ignored in this country at the present time. What is required is a well-equipped staff, including specialists in botany, physics, chemistry and physiology, to provide training for students, to institute research and furnish expert advice. Neither at Kew, which, as Prof. Bayley Balfour later expressed it, acts as the clearing-house for the Empire, nor elsewhere is such a staff to be found. The study of vegetable economics might, in Prof. Bower's opinion, be advantageously pursued in commercial centres such as Glasgow, Liverpool and Belfast, and he has laid before the authorities of his University the desirability of appointing a special lecturer in this subject.

ON December 3, a conference on "Nature-study" was held with special reference to the development of the work of Stepney Borough Museum with the schools. Mr. J. H. Wylie presided over the meeting, which was held in the Art Gallery, and Canon Barnett, in welcoming the audience, brought forward a suggestion that the winter garden of the People's Palace should be made into a Nature-study centre. Mr. A. D. Hall gave a general address and offered no explanation of the meaning of Nature-study, saying that as most of his audience were teachers that difficulty was removed. He urged that living things should be studied, not collections of dead things in boxes, and suggested the growing of food plants in East-end schools. Bean seedlings, he said, could be measured by the children, who could then make curves illustrating the growth on squared paper. His only allusion to the Museum was in connection with a supposed annual outing of the children, and he suggested that the journey then undertaken might be illustrated in the institution. Prof. Farmer alluded to the help as regards material to be obtained from the Chelsea Physic Garden. The Rev. Claude Hinscliff stated that the object of the conference had been lost sight of, and showed the necessity of opening the eyes of the East-ender by means of the Museum to what he might see when he did go into the country. Mr. F. C. Mills, the chairman of the Museum committee, expressed his pleasure as regards the interest taken in the conference, in spite of the fact that its purpose had been unfulfilled. The School Board inspector for the district alluded to work such as that suggested by Mr. Hall and of an elementary biological nature having been carried on for years at the schools in which he was interested. Mr. Wilfred Mark Webb urged the teachers not to introduce formal and systematic lessons, and Miss Kate Hall, the curator of the Museum, who had organised the conference, spoke of her intentions and requirements.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 27.—"Descending Intrinsic Spinal Tracts in the Mammalian Cord." By C. S. Sherrington, M.A., M.D., F.R.S., and E. E. Laslett, M.D.Vict.

Experiments inquiring into the existence of spinal paths connecting the activity of segments situate nearer the head with segments lying further from the head.

The method adopted may be termed the method of "*successive degeneration*." It consists in producing two or more successive degenerations with allowance of a considerable interval of time between them. In the piece of cord to be examined, a first degeneration is allowed time enough to remove all the tracts descending from sources other than those the immediate object of inquiry. When the time is complete, the cord is left, as it were, like a cleaned slate, on which once more a new degeneration can be written without fear of confusion with a previous one. The cord is then ready for receiving the lesion which shall cause degeneration of the particular tracts the existence of which is suspected. After a period suitable for the full development of the new degeneration, the cord is treated histologically by the Marchi method, and the microscopical examination proceeded to.

Results.

The spinal segments examined as sources of aborally-running fibre-systems have been posterior cervical, anterior thoracic, mid thoracic, posterior thoracic and anterior lumbar. From all these regions, the experiments demonstrate that copious aborally-running fibre-systems spring.

Speaking generally, of the fibres composing the aborally-running systems springing from the grey matter of the spinal segments examined, there may be distinguished two sets. For physiological description, it is in some ways convenient to regard the length of the spinal cord as divisible into regions; thus, a brachial for the fore limb, a thoracic for the trunk, a crural for the hind limb, a pelvic for pelvic organs, a caudal for the tail, and so on. A reflex initiated *viâ* an afferent path of one such spinal region may evoke its peripheral effect by efferent paths of a spinal region other than that to which the original entrant path belongs. Such a reflex has in a former paper by one of us [1] been termed a "long" spinal reflex, in contradistinction to reflexes the centripetal and centrifugal paths of which both belong to one and the same spinal region. The latter reflex it was proposed to term "short." [2] Analogously, in the aborally-running fibre-systems of the spinal segments examined, by our experiments fibres of two categories are found, one a set passing beyond the limits of the spinal region in which they arise, the other not passing beyond those

[1] C. S. Sherrington, "Croonian Lecture," *Phil. Trans.*, 1897.
[2] *Ibid.*

limits. The former we would term "long spinal," the latter "short spinal" fibres. In each of these main categories, there can be distinguished fibres of various intermediate length.

Again, the fibres of each of the above two categories may be classified into two sets or tracts, according to their topography relatively to the cross-section of the cord. Fibres of both of the above categories are situate both in the lateral columns and in the ventral columns of the cord. It is useful, at least for descriptive purposes, to indicate this by terminology. We thus recognise in the aborally-running intrinsic spinal fibre systems the following sets or tracts :—(α) *Ventral short fibres*, (β) *Ventral long fibres*, (γ) *lateral short fibres*, (δ) *lateral long fibres*. It must be added that the distinction into lateral and ventral is somewhat artificial, as there exists often, especially in the case of the "short" fibres, no distinct gap between the ventral and lateral fields of distribution of the fibres in the transverse area of the cord.

The paper concludes with an analysis of evidence as to decussation of the long and short fibres.

December 11.—"Quaternions and Projective Geometry." By Prof. Charles J. Joly, F.T.C.D., Royal Astronomer of Ireland. Communicated by Sir Robert S. Ball, F.R.S.

The object of this paper is to include projective geometry within the scope of quaternions.

Chemical Society, December 4.—Dr. W. H. Perkin, F.R.S., vice-president, in the chair.—The following papers were read :—The specific heats of liquids, by Mr. H. Crompton. When heat is applied to an unassociated liquid, there is an increase in molecular kinetic energy, internal work is done within each molecule, intermolecular attraction is diminished and a small amount of external work is done. The first two factors together make up the specific heat at constant volume. The evaluation of the diminution of intermolecular attraction is made by the author on the assumption that the total attraction is equal to the difference between the latent heat of vaporisation and the heat evolved when the vapour is compressed to the volume it would occupy as a liquid but without undergoing this change of state. Assuming that this attraction is zero at the critical point and increases regularly with decrease of temperature, its change with temperature is given by the expression $(L - RT \log V/v)/(T_k - T)$, where L is the latent heat, T_k and T the absolute critical temperature and absolute temperature respectively, V and v the volumes of the vapour and liquid respectively. Neglecting the fourth factor, viz., the external work done, the author shows that the molecular heats of various liquids for which the foregoing data are available agree fairly well with those calculated by this method.—The constitution of enolic benzoylcamphor, by Dr. M. O. Forster. It is shown that this substance is probably phenylhydroxymethylenecamphor from a consideration of the derivatives and decomposition products obtained from it.—Isomeric benzoyl derivatives from isonitrosocamphor, by Dr. M. O. Forster. Two isomerides have been obtained ; one crystallises in yellow prisms and melts at 105° ; the other is colourless, melts at 136° and does not give isonitrosocamphor on hydrolysis.—Action of phosphorus haloids on dihydroresorcins, by Drs. Crossley and Le Sueur.—The absorption spectra of metallic nitrates, ii., by Prof. Hartley. The positions of the characteristic absorption bands depend upon the molecular weights of the salts in solution. The characters of the spectra observed are equally well explained by the assumption that *partial* ionic or *partial* hydrolytic dissociation occurs on solution.—The constitution of the products of nitration of *m*-acetoluidide, by Dr. J. B. Cohen and H. D. Dakin.—The action of metallic thiocyanates upon carbonyl chloride, by Dr. A. E. Dixon. A description of the substituted thiocarbimides obtained.

Entomological Society, November 19.—The Rev. Canon Fowler, president, in the chair.—Dr. Sharp, F.R.S., exhibited the egg-cases made by a beetle of the genus Aspidomorpha (*A. puncticosta*), and stated that they had been sent to him by Mr. F. Muir, of Durban, Natal, where the beetle and the egg-cases are common.—Dr. Norman H. Joy exhibited a well-marked aberration of a female *Lycaena icarus* striped black on the underside in the place of the usual ocellations ; a gynandromorphous specimen of the same species ; an aberration of a male *Lycaena bellargus*, similarly striped on the underside ; a specimen of *Everes argiades* taken in 1885 at Bournemouth ; and specimens of *Apatura iris* from the neighbourhood of Reading, taken from what appeared to be the throne of the ruling "Emperor" of the wood. Whenever another iris came by, the one on the "throne" attacked it, and after a fight, in which one would eventually pursue the other out of sight, the victor returned to the perch. If this was captured, the next *iris* coming along would take possession, and so on.—Mr. Claude Morley exhibited a specimen of *Diastictus vulneratus*, Sturm., new to Great Britain, and a rare blue form of *Miratora vitellinae* from Tuddenham Fen.—Mr. G. C. Champion exhibited specimens of *Nanophyges durieuri*, Lucas, a beetle from Central Spain, with drawings of the larva, pupa and perfect insect.—Prof. E. B. Poulton, F.R.S., stated that Mr. A. H. Church, of Jesus College, Oxford, had observed the larvæ of a species of Cucullia (probably *C. verbasci*), feeding upon *Buddleia globosa* which was growing against a wall in the Oxford Botanical Gardens. It is possible that the eggs were laid upon the Buddleia because of the very rough general resemblance in certain respects between its leaves and those of Verbascum. Mr. R. McLachlan, F.R.S., mentioned the case of *Mamestra persicariae*, at Lewisham, choosing *Anemone japonica*. He had offered them fern and elder (which is reputed a favourite food), but the larvæ refused everything except the original anemone. Mr. Goss said that larvæ of *Choerocampa elpenor*, taken at Weybridge from a species of American balsam, afterwards refused willow herb, the usual food-plant of the species. Prof. Poulton read a communication from Mr. G. F. Leigh relating to the enemies of Lepidoptera in Natal. The very common grey South African rat seems to be particularly fond of almost any pupæ, and will gnaw through thick wooden boxes to get at them. They affect especially *Choerocampa eson* and *C. nerii*. Even more remarkable than their keenness in hunting pupæ is the way in which they capture moths on the wing when feeding. Whilst flying at dusk, a rat would leap from the roof right on to their food-plant, and more often than not the moth selected for attack was captured. Bats are also very destructive of South African insect-life.

Ray Society, December 11.—Council Meeting.—Mr. John Hopkinson, treasurer, in the chair.—A vote of condolence with the widow and family of the late secretary of the Society, the Rev. Dr. Wiltshire, was passed, and in his place Mr. Hopkinson was elected secretary. The question of the appointment of treasurer was not finally decided.

MANCHESTER.

Literary and Philosophical Society, December 2.—Mr. Charles Bailey, president, in the chair.—Mr. C. L. Barnes showed a number of experiments depending on Hawksbee's law, viz., that the pressure on the walls of a tube containing a fluid is less when the fluid is in motion than when it is at rest. Several of these are well known, *e.g.*, the apparent attraction which results when a current of air, radial or other, passes between two parallel discs, and the suspension of a ball on a jet of air or water. Other illustrations of the principle are that it is impossible to blow a celluloid ball, or even an inflated toy balloon, out of a funnel held in the ordinary upright position, though, if the funnel be reversed, the ball or balloon can be supported without difficulty. Also, if a couple of celluloid balls are placed on a kind of railway made by fastening two rods to one another, they cannot be separated by blowing between them. The experiment of forcing a celluloid ball out of a tall glass cylinder by blowing downwards upon it was also performed, as were also several others of a similar character.—Mr. Frank Southern exhibited and described a Japanese magic mirror, and Dr. C. H. Lees showed a small piece of apparatus used in the determination of the thermal conductivities of solids over wide ranges of temperature. It consists in principle of a differential hydrogen thermometer, one bulb of which is heated by an electric current either in a flat strip of metal wound round it or passing through the material of the bulb itself.

DUBLIN.

Royal Dublin Society, November 18.—Prof. D. J. Cunningham, F.R.S., in the chair.—Prof. T. Johnson read a paper on *Phellomyces sclerotiophorus*, Frank, a fungus of unknown affinities which causes a form of scab in potato-tubers and, in extreme cases, a dry rot. The author first observed the fungus in several potato varieties, grown in the west and other parts of Ireland, in the autumn of 1901.—Phellomyces causes the formation of discoloured patches in the skin of the tuber, in the midst of which are generally present the minute sclerotia, 0·1 mm. in diameter, just recognisable, in washed tubers, with the naked eye. In mild attacks, the fungus simply makes the tuber unsightly; in more severe cases, it strips off layer after layer of the protecting skin of the tuber, and may ultimately penetrate through the skin into the flesh of the tuber, killing the protoplasm, sending the mycelial hyphæ between and through the cells, and boring into the starch grains. Both in appearance and action, Phellomyces is readily distinguishable from Rhizoctonia, an extremely common cause of scab and rot in potatoes. Phellomyces can pass from seed tubers to the resulting crop, and is communicable from infected ground to healthy tubers grown in it. The author found soaking the diseased tubers in 0·8 per cent. solution of formalin for 1½ hours destroyed the fungus, untreated diseased tubers giving, under otherwise similar conditions, a diseased crop. Three varieties imported from France, planted in Connemara, gave crops showing *Sclerotinia sclerotiorum* and *Phellomyces sclerotiophorus*, both unknown in France on the potato up to the present time. Frank first saw the fungus, in various parts of Germany, in 1894, and again in succeeding years. The author said he had nothing to add to the account given by Frank of its very imperfectly known life-history.—Mr. Leonard Murphy read a paper on a new method of determining the amount of liquid in distant and inaccessible tanks, &c.—Mr. G. H. Carpenter exhibited lantern slides of insects (Collembola) taken in Mitchelstown and Dunmore caves in the south of Ireland, pointing out that while some of the species seemed to be confined to such localities and to represent special modifications for life in caves, others were identical with insects found in the upper world with a discontinuous range, and must be regarded as the survivors of very old races.

EDINBURGH.

Royal Society, November 3.—The Hon. Lord M'Laren, vice-president, in the chair.—The chairman in his opening remarks made special reference to the publication of the Ben Nevis observations, the first volume of which had just been issued. Half the expense of these publications, which would fill three volumes of the *Transactions*, was being borne by the Royal Society of London. Another matter of special interest was the systematic bathymetrical survey of the Scottish lakes which had been organised by Sir John Murray and Mr. Laurence Pullar. During the seven months beginning March last, they had surveyed 153 lochs and taken nearly 24,000 soundings. The greatest depth observed was in Loch Morar, 1009 feet, which exceeds by several hundred feet the depth recorded in any other lake in the British Islands. In addition to the routine work of taking soundings and determining heights, observations of temperature and of "seiches" and collections of plankton and bottom deposits were made by the staff. The results were now being prepared for publication in Edinburgh, and preliminary papers dealing with the work would from time to time be laid before the Society.—Sir William Turner communicated a paper entitled "Contributions to the Craniology of the People of Scotland." The material had been collecting for many years in his hand, and in this first paper he gave the detailed results of the measurement of nearly 200 skulls obtained from all parts of Scotland. Of these, 28 per cent. were dolichocephalic, 20 per cent. brachycephalic, and 52 per cent. belonged to the intermediate group. As regards their distribution, the brachycephalic type was characteristic of Fife, the Lothians, the eastern counties between the Tay and the Moray Firth, and Shetland; whilst the dolichocephalic type was most prevalent in Renfrewshire, Wigtonshire, Caithness and the Highlands. A very marked percentage of the brachycephalic skulls had distinct frontal sutures, a very unusual feature in adult skulls. This indicated growth in breadth during adult life. The skulls were capacious and somewhat above the average for western Europe. As regards the facial characters, the orbits were wide and circular and the noses long and narrow. The discussion of the ethnographical bearing of the facts was reserved for a second paper.—In a paper on the electrical conductivities and relative densities of certain samples of sea-water, Mr. J. J. Manley described some novelties of method in the accurate measurement of these quantities. The results were negative, there being no discoverable relation between the conductivities and densities.—Two papers by Dr. Thomas Muir on generating functions of certain determinants were also presented.

November 17.—The Rev. Prof. Duns in the chair.—Dr. W. G. Aitchison Robertson read a paper on the local distribution of cancer in Scotland. In collecting his material, he had visited many of the larger institutions and infirmaries throughout Scotland, and from careful inspection of the registers had, as far as possible, allocated the various cases to their proper counties. In this respect, he believed that his statistics were more accurate than those derived directly from the reports of the Registrar-General, for it was quite evident that many of the cases recorded as having occurred in the larger towns really belonged to neighbouring or even remote country districts. His corrections made important changes in the chart of distribution. Thus, when corrected for the presence of strangers, the cancer mortality for the city of Edinburgh fell from 5·15 per cent. (as it appeared to be from the Registrar-General's returns) to 4·13 per cent., which is practically the normal for the whole of Scotland. On the other hand, by the same correction the cancer mortality for the county of Edinburgh increased to nearly 5 per cent. On the whole, the mainland rural districts and smaller towns had a higher cancer mortality than the large towns and cities. In the county of Nairn, the mortality was 9·73 per cent. In the outer Hebrides, the mortality was distinctly below the normal for Scotland. The statistics showed many curious features, and it was utterly impossible to connect the distribution with climatic or geologic conditions, or with race or food supply. That the towns were healthier than the rural districts seemed to dispose of several of the ordinary theories as to the undoubted increase of the disease within the last half-century. This could be regarded as only a first effort to get at information regarding local distribution of cancer, and Dr. Robertson urged upon the medical profession in Scotland the importance of a combined investigation of the causal relations of this dread disease.—Mr. J. Ross communicated a short note on the trisection of an angle, and a paper by Dr. Thomas Muir on pure periodic continued fractions was also read.

PARIS.

Academy of Sciences, December 8.—M. Bouquet de la Grye in the chair.—The president announced to the Academy the death of two members, M. Dehérain, member of the section of Rural Economy, and M. Hautefeuille, member of the section of Mineralogy.—On the transformation of the diamond into black carbon during its oxidation, and on the isomeric changes of simple bodies during decompositions and combinations, by M. Berthelot. Some remarks on work recently published by M. Moissan.—On the irreducibility of the equation $y'' = 6y^2 + x$, by M. Paul Painlevé.—On the quantity of free hydrogen in the air and the density of atmospheric nitrogen, by M. Armand Gautier. Four years ago, the author published work proving the existence of free hydrogen and methane in the air, and estimated their quantity. The proportion of hydrogen then found has been questioned by Lord Rayleigh, and M. A. Leduc has recently adduced other evidence in confirmation of Lord Rayleigh's objections. It is shown that the exact concordance between the percentage of oxygen by weight found by M. Leduc and the value calculated from the densities of the gases is accidental, and that the results are quite consistent with the presence of the amounts of hydrogen and methane found by the author.—On the development of the Peripatidæ of South Africa, by M. L. Bouvier.—On some Hæmogregarians of Ophidians, by M. A. Laveran.—The internal action of copper sulphate in the resistance of the potato to *Phytophthora infestans*, by M. Émile Laurent. The experiments described led to the conclusion that potato tubers should be immunised against this fungus by dipping them for a certain time in a solution of copper sulphate, but on actual trial it was found that potatoes so treated and then purposely infected with the Phytophthora were attacked as vigorously by the parasite as the untreated tubers.—Observations of the new comet Giacobini (*d* 1902), made at the Observatory of Paris, by MM. G. Bigourdan, G. Fayet and P. Salst. On December 6, the comet was a nebulosity of magnitude 13·2, diffuse, vaguely rounded and of 30″ diameter.—Provisional elements of the Giacobini comet, by M. G. Fayet.—On the properties of the plane from the point of view of the *Analysis situs*, by M. Combebiac.—On a summatory form in the theory of functions of two variables, by M. Martin Krause.—

On a dark chamber for three-colour photography, by M. Prieur. The problem to be solved was to devise a mechanism which, on closing the shutter, would remove the exposed plate and at the same time replace it by the succeeding plate, placing the latter accurately in the focus of the objective. This problem has been satisfactorily solved.—On bipolar electrodes with a soluble anode, by MM. André Brochet and C. L. Barillet. In an electrolytic cell containing a solution of copper sulphate, the interposition of an insulated copper plate gives results very similar to those previously described with a platinum plate. It was not found possible to predict the phenomenon in any given case.—On thallic chloride, by M. V. Thomas. The chloride $TlCl_3, 4H_2O$ can be dehydrated in a vacuum without any loss of chlorine. The properties of the anhydrous chloride are given.—On Gmelin's violet manganese metaphosphate, by M. Ph. Barbier.—Addition derivatives from cyclohexene, by M. L. Brunel.—On a dichlorhydrate and dibromhydrate of cadinene and on a dextrorotatory regenerated cadinene, by M. Emilien Grimal.—On the essence of vetiver, by MM. P. Genvresse and G. Langlois. This essence contains a sesquiterpene, a sesquiterpene alcohol, and an ester to which the odour is due.—On the excretion and variation of the kidney in carnivorous fowls of the second generation, by M. Frédéric Houssay.—The formation of chlorophyll in rarefied air and in rarefied oxygen, by M. Jean Friedel. In air expanded to one-sixth of the atmospheric pressure, the leaves of Phaseolus are almost entirely etiolated; in oxygen at the same pressure, the leaves are coloured as in ordinary air. It would thus appear that the relative pressure of the oxygen is the predominating factor, the total pressure having no sensible influence.—On some new fossil infusoria, by M. B. Renault.—On the immunisation of the lettuce against the fungus *Bremia Lactucae*, by M. E. Marchal. By treatment with solutions of copper sulphate of certain strength, it was found possible to prevent the growth of the parasite from interfering with the growth of the plant. The narrow margin, however, between the immunising dose of copper sulphate and that capable of acting injuriously on the lettuce plant renders the practical application of these results difficult.—Some mineralogical observations made on the products from the burning of St. Pierre, Martinique, by M. A. Lacroix.—On the Palæozoic earths of Oued Saoura and Gourara, by M. E. F. Gautier.—On economic appreciation and improvements due to cultivation, by M. E. Rabaté.—On the application of chemical manures to the cultivation of the vine in the calcareous earths of Charentes, by MM J. M. Guillon and G. Gouirand.—On some exotic Graminaceæ employed in food, by M. Balland.—On some brilliant red sunsets observed at Athens during the months of October and November, 1902, by M. D. Eginitis.

NEW SOUTH WALES.

Linnean Society, October 29.—Mr. J. H. Maiden, president, in the chair.—On two remarkable Sporocysts occurring in *Mytilus latus*, on the coast of New Zealand, by Prof. W. A. Haswell, F.R.S.—(1) On *Eucalyptus polyanthemos*, Schauer; (2) on *E. bicolor*, A. Cunn, by Mr. J. H. Maiden. The author quotes the original descriptions of the species, cites their synonyms, discusses their affinities and gives an account of their range.—Contributions to a knowledge of the Australian flora, part iv., by Mr. R. T. Baker. A number of new localities for species are recorded, thus extending their known geographical range.—Notes on the botany of the interior of New South Wales, part vii., by Mr. R. H. Cambage. The conspicuous vegetation of the country between Forbes and Bathurst is described.—On the mammalian and reptilian vomerine bones, by Dr. R. Broom. The author shows that in the early stages of development the nasal capsules of the lizard and marsupial are essentially similar in structure and that in both a well-developed paraseptal cartilage runs by the base of the septum from the nasal floor cartilage in front to the hinder part of the capsule. He also shows that the so-called "vomer" in the lizard develops in connection with this cartilage; and as the dumbbell-shaped bone in Ornithorhynchus and the median bone of Miniopterus also develop as splints to the paraseptal cartilages (specialised as cartilages of Jacobson), he concludes that these mammalian bones are homologous with the so-called "vomers" of the lizard and are therefore really *prevomers*.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 18.

LINNEAN SOCIETY, at 8.—Notes on Copepoda from the Faeroe Channel: Thos. Scott.—Amphipoda of the *Southern Cross* Antarctic Expedition; Alfred O. Walker.—The Deep-Sea Isopod *Anurus branchiatus*, Bedd.: Dr. H. J. Hansen.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes of Recent Electrical Designs: W. B. Esson.

FRIDAY, DECEMBER 19.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Electricity Supply from Double Current-Generators: P. R. Wray.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Recent Practice in the Design, Construction and Operation of Raw Cane Sugar Factories in the Hawaiian Islands: J. N. S. Williams.

TUESDAY, DECEMBER 23.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*:—The Rupnarayan Bridge, Bengal-Nagpur Railway: S. Martin-Leake.—*Paper to be read*:—Electric Automobiles: H. F. Joel.

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